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ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

Report of the Sixteenth Meeting.

The sixteenth meeting of the Astronomical and Astrophysical Society of America was held in connection with the American Association for the Advancement of Science in Atlanta, Georgia, on December 29, 1913 to January 1, 1914. As Atlanta seemed rather remote or out of the usual track to many of the members, the attendance was small. But those present found it a fine, thriving, hospitable city.

Four sessions were held for the presentation of papers. The president, Professor Pickering, was unable to be present at all meetings on account of his duties to the American Association; in his absence Professor Comstock presided. The meetings were held in a class room of the Georgia Technical College or in the parlors of the Piedmont Hotel.

On Monday evening all members present attended the meeting of the A. A. A. S. to hear the address of the retiring president, Professor E. C. Pickering, who spoke on "The Study of the Stars". This address printed in Science* for January 2, 1914 contained a resumé of the history and late results of astronomical research. Incidentally it contained a sharp criticism of the plan of organization of the Naval Observatory. On Tuesday evening an informal conversazione was held. Numerous photographs and diagrams showing various phases of astronomical work were exhibited. It is hoped that this pleasant feature will be repeated at subsequent meetings. It is well to have this in mind through the year that representative exhibits may be prepared.

* See also P. A. **22**, 65, 1914.

On Tuesday afternoon the Society met in joint session with Section A of the Association and listened to the admirable address of the retiring Vice-president of the Section, Professor E. B. VanVleck, on "The Influence of Fourier's Series upon the Development of Mathematics." The Society was represented by Professor H. N. Russell whose address, "Relations between the Spectra and Other Characteristics of the Stars", appears at the end of this report. *

Two general receptions of a purely social nature were tendered to the Association and affiliated societies and were very largely attended; on Monday evening at the University Club and on Tuesday evening from five to seven o'clock by Governor and Mrs. John M. Slaton at the gubernatorial mansion.

As the American Association proposes to hold large general meetings at four year intervals, when it is hoped that all the affiliated societies will participate, the Council voted to adopt as the policy of the Society, to endeavor to meet at such times with the Association.

The Council elected the following persons to membership in the Society:

The Rev. T. H. E. C. Espin, Tow Law, Co. Durham, England.
Dr. C. C. Kiess, Laws Observatory, Columbia, Mo.

and unanimously, to Honorary Membership, under the provision of the Constitution which enables the Society to elect to this honor one foreign astronomer of distinction at each annual meeting,

Professor G. F. J. Arthur Auwers.

The number of members in attendance was too small to furnish a quorum for a valid election. The officers elected at Pittsburgh in 1912 will therefore continue in service.

President	E. C. Pickering
First Vice President	G. C. Comstock
Second Vice President	Frank Schlesinger
Secretary	Philip Fox
Treasurer	Annie J. Cannon
Councillors 1911-1913	W. S. Eichelberger
	J. S. Plaskett
Councillors 1912-1914	W. W. Campbell
	E. B. Frost

The members in attendance were:

G. C. Comstock	Otto Klotz
W. S Eichelberger	F. R. Moulton
Philip Fox	E. C. Pickering
C. H. Gingrich	W. F. Rigge
C. S. Howe	H. N. Russell
W. J. Humphreys	Frederick Slocum

The next meeting of the Society will be held at Northwestern University, Evanston, Ill., in August of 1914.

* This address will appear in the next number of POPULAR ASTRONOMY.

The abstracts of the papers and the report of the Committee on Photographic Astrometry, are given below. To facilitate reference the abstracts are arranged, according to authors, alphabetically.

ABSTRACTS.

NOTE ON THE RELATIVE INTENSITY AT DIFFERENT WAVE-LENGTHS OF THE SPECTRA OF SOME STARS HAVING LARGE AND SMALL PROPER MOTIONS. *

By W. S. Adams.

A comparison of the spectra of a number of pairs of stars of the same spectral type photographed side by side on the same plate and at the same zenith distance shows that in no case is the spectrum of the star of small proper motion stronger at the violet end of the spectrum than that of the nearer star, but in a large majority of cases is weaker. The difference in some cases is very great. An investigation of some stars of greatly different absolute brightness tends to show that the effect observed is not due to this source, although the material is as yet insufficient to make this conclusion certain.

NOTE ON THE PRESENT SPECTRA OF THREE OF THE NOVAE.

By W. S. Adams and F. G. Pease.

Photographs of the spectra of Nova Persei (1901), Nova Lacertae (1910), and Nova Geminorum (1912), show the presence of strong nebular lines in the last two stars and their complete absence in Nova Persei. The continuous spectrum is strong in the first two stars and absent in Nova Geminorum. The width and structure of the bright lines is identical in Nova Lacertae and Nova Geminorum. To judge from these three stars the spectrum of temporary stars becomes the more like that of the Wolf-Rayet stars the longer the interval since their outburst.

A SIMPLE METHOD OF CONSTRUCTING THE NORMALS TO A PARABOLA.

By S. G. Barton.

We know from Harvey's Theorem that the feet of the three normals to a parabola from any point lie on a circle which passes through the vertex. The converse is also true, the normals whose feet lie on a circle through the vertex are concurrent. Let (d, e) be the center of such a circle. Its equation then is

* Ap. J. **39**, 89, 1914.

$$x^2 + y^2 - 2dx - 2ey = 0$$

which intersects the parabola $y^2 = 4px$ in points whose ordinates are given by

$$y^3 - 8p(d - 2p)y - 32p^2e = 0$$

Since this lacks the second term the sum of its roots is zero, which is the condition for concurrent normals.

The equation giving the ordinates of the feet of the normals through a point (h, k) is

$$y^3 - 4p(h - 2p)y - 8p^2k = 0$$

But these two equations must be equivalent, hence equating coefficients

$$2d - 4p = h - 2p \text{ and } 32e = 8k.$$

Therefore $d = \frac{1}{2}h + p$ and $e = \frac{1}{4}k$.

Hence to construct the normals from the point (h,k), find the feet by constructing a circle whose center is $(\frac{1}{2}h + p, \frac{1}{4}k)$ and radius such that it passes through the vertex of the parabola. The intersections of the circle with the parabola, other than the vertex are the feet of the three normals.

If the point (h,k) is on the convex side of the evolute of the parabola, the three normals are real and distinct; if *on* the evolute, two of the normals are coincident, all three coinciding at the cusp; if on the concave side, two normals are imaginary. Under the same circumstances the center of the circle will bear the same relation to the locus $(x - 2p)^3 = \frac{27}{2}py^2$.

If there is difficulty in locating the exact point of intersection, it will often be of aid to recall that the sum of the three ordinates must vanish.

A GRAPHICAL SOLUTION FOR CUBIC EQUATIONS.

By S. G. Barton.

Since there are three normals to a parabola, the location of their feet by the above construction solves a cubic equation. This leads to a general solution.

PROPER MOTIONS OF TELESCOPIC STARS.

By G. C. Comstock.

The writer has discussed in A. J. No. 655 the results derived from an investigation of the proper motions of some 500 stars ranging from the

seventh to the thirteenth magnitude. Employing the relation there established between magnitude and proper motion, there is here presented an investigation of the relative numbers of large and small proper motions, i. e. a frequency curve.

SPECTROSCOPIC NOTES FROM THE DETROIT OBSERVATORY.

By R. H. Curtiss.

From the Potsdam and Detroit Observatory velocity observations of δ *Orionis* the following values of the period of this system are found:

From the first and second Potsdam series,

Epoch, 1897.....5.73245 ± 0.00013 days.

From Ann Arbor and second Potsdam series,

Epoch, 1907.....5.73248 ± 0.000022 days.

In an interval of ten years it is probable that there has been no change greater than ten seconds in the average period.

Using Rowland's wave-lengths, the Detroit Observatory observations of the K and H lines yield the velocities, +12.8 ±1.0 km and +16.9 ±2.1 km respectively. This is in satisfactory agreement with Hartmann's values for the K line, based on an unknown wave-length. The tendency toward a negative displacement of the calcium lines with reference to the oscillating lines is confirmed. D_1 and D_2, if present, are weak and sharp like the K line.

With the exception of K of Calcium, all the lines which the writer has studied in the spectrum of *P Cygni* seem to include an emission component, not always distinguishable from the continuous spectrum, with an absorption line on the edge of the shorter wave-length. In the case of the lines of *H* and *He*, weak absorption is visible on the edge of the emission, of greater wave-length. The strong absorption component is displaced toward the violet from the normal position of the line by an amount which seems to depend roughly upon the strength of the emission component. The table following gives the displacement in kilometers of various typical lines in *P Cygni's* spectrum. The "wide absorption lines", only the edges of which are visible are assumed to have the emission lines superposed upon them.

Lines	Elements	Displacement	Observer
Absorption			
Hδ, *Hγ*, *Hβ*.	H	—196 km	Frost
4388, 4471, 4713	He	—146 km	Frost
4553, 4568, 4575	Si	— 88 km	Frost and Merrill
4089, 4097, 4116	Si and N?	— 50 km	Curtiss
3934, K.	Ca	— 17 ± 1.6 km	Curtiss
Emission	H,He,O,N,Si	— 10 km	Merrill
Wide Absorption	H, He	+ 2 km	Curtiss

Possibly the K line yields a value for the radial velocity of *P Cygni* nearest the true value.

Three spectrograms each of the components of η *Cassiopeiae* show that the spectra of these stars are very similar in the region from λ 4200 to λ 4900. Velocity measures yield nearly identical results for these bodies, namely, about 8 kilometers per second, positive.

In the spectrum of β *Leonis*, many of the metallic lines, including the K line, are close doubles, their structure suggesting a binary character or reversal by central emission. Measures by Mr. L. L. Mellor show that the separation in Ångstroms of the dark components of any line is constant and, for different lines, increases in direct proportion to the wave-length, suggesting strongly a pressure effect.

ERRORS IN THE RIGHT ASCENSIONS OF NEWCOMB'S CATALOGUE.

By W. S. Eichelberger and H. R. Morgan.

This paper consists chiefly of a discussion of the results obtained from observations of the 277 stars contained in the clock list of the 9-inch transit circle of the U. S. Naval Observatory during the years 1903 to 1911 inclusive.

It enumerates the precautions taken to eliminate the effect of the personal equation of the various observers in observing the time of transit of a star, the effect of magnitude equation in right ascension, and the effect of the variation of clock correction with declination due to the meridian of the instrument and that of Newcomb's Catalogue not coinciding throughout.

All azimuths were made to depend upon fundamental positions of the azimuth stars deduced from observations with the 9-inch transit circle during the progress of the work. These fundamental positions give the following corrections to Newcomb's positions:

From Eye and Ear Observations.				From Chronograph Observations.	
	$\Delta\alpha$		$\Delta\alpha$		$\Delta\alpha$
	s		s		s
λ Urs. Min.	−0.22	51 H. Cephei	+0.57	ϵ Urs. Min.	−0.01
4B " "	+0.46	39 H. Cephei	+1.38	76 Draconis	+0.02
α " "	+1.24	δ Urs. Min.	−0.02	1H. Draconis	−0.01
6B " "	+0.45	43 H. Cephei	+0.24		
57B " "	−0.59	151 H. Cephei	+0.26		

The paper also details the methods employed to eliminate from the final results, the effect of the systematic and accidental errors of Newcomb's right ascensions.

The final positions of these 277 clock stars, deduced from over 7000 observations on 410 different nights, furnish corrections to Newcomb's positions which when grouped according to declination and right ascension give the following table:

SYSTEMATIC CORRECTIONS TO THE RIGHT ASCENSIONS OF NEWCOMB'S FUNDAMENTAL CATALOGUE.

δ \ α	h h 0—3	h h 3—6	h h 6—9	h h 6—12	h h 12—15	h h 15—18	h h 18—21	h h 21—24	Mean
° °	s	s	s	s	s	s	s	s	s
+30 to +20	+0.015	+0.005	−0.001	+0.016	+0.007	+0.013	+0.028	+0.008	+0.011
+20 to +10	+0.040	+0.019	+0.006	+0.020	+0.018	+0.016	+0.039	+0.031	+0.024
+10 to 0	+0.025	+0.028	+0.004	+0.016	+0.018	+0.038	+0.036	+0.038	+0.026
0 to −10	+0.034	+0.027	+0.010	+0.020	+0.032	+0.044	+0.034	+0.042	+0.030
−10 to −20	+0.048	+0.054	+0.026	+0.040	+0.047	+0.054	+0.051	+0.061	+0.048
Mean	+0.032	+0.027	+0.009	+0.022	+0.024	+0.033	+0.038	+0.036	+0.028

If we subtract from the quantities in each of the first five rows, the mean as given in the last column, we obtain the set of corrections immediately following, in which the mean correction and the variation with declination are eliminated. Using the mean values in the sixth row, the analytical expression immediately following the table was obtained, and the values in the last row are those resulting from the use of this expression.

δ \ α	h 1.5	h 4.5	h 7.5	h 10.5	h 13.5	h 16.5	h 19.5	h 22.5	Range
°	s	s	s	s	s	s	s	s	s
+25	+0.004	−0.006	−0.012	+0.005	−0.004	+0.002	+0.017	−0.003	0.029
+15	+0.016	−0.005	−0.018	−0.004	−0.006	−0.008	+0.015	+0.007	0.034
+ 5	−0.001	+0.002	−0.022	−0.010	−0.008	+0.012	+0.010	+0.012	0.034
− 5	+0.004	−0.003	−0.020	−0.010	+0.002	+0.014	+0.004	+0.012	0.034
−15	0.000	+0.006	−0.022	−0.008	−0.001	+0.006	+0.003	+0.013	0.035
Mean	+0.005	−0.001	−0.019	−0.005	−0.003	+0.005	+0.010	+0.008	
Formula	+0.007	−0.004	−0.013	−0.010	−0.002	+0.004	+0.008	+0.010	

$$\Delta\alpha = -0.008 \sin\alpha + 0.008 \cos\alpha + 0.002 \sin 2\alpha + 0.002 \cos 2\alpha.$$

It is expected to publish the paper entire in the Astronomical Journal.

MICROMETRIC OBSERVATIONS OF THE HOLDEN AND KÜSTNER DOUBLE STARS.

BY PHILIP FOX.

All of the double stars included in the series of Holden and of Küstner have been on my observing list and have now been completely remeasured. I am indebted to Mr. Innes of the Union Observatory in Johannesberg for measures of the eleven Holden southern stars discovered while observing in the Caroline Islands. The stars showing clear indication of motion are βGC **2824** = Hn 76, **7039** = Hn 120, **10128** = Hn 128, **10651** = Hn 165, the binary **12696** = Hn 60, **6667** = Kü 47.

OBJECTIVE-PRISM SPECTRA OF NEBULAE EXAMINED WITH THE STEREOCOMPARATOR.

By Edwin B. Frost and Harold L. Alden.

The difficulty in studying the spectra of large nebulae on plates taken with the prismatic camera is due primarily to the faintness of the objects and to the absence of well defined points of reference. With the Zeiss "ultra-violet" doublet of 145 mm aperture and its objective prism of the same aperture and 15° angle, the optical efficiency is good. It therefore seemed worth while to photograph the spectra of some of the nebulae with this instrument, and exposures were made by Mr. Alden on the field in Cygnus including the well known nebulae N.G.C. 6960 and 6992. The features shown are naturally faint and might escape attention. Here enters the advantage of the stereo-comparator, or more properly the "Blink-Mikroskop", the monocular attachment of that instrument. Professor Barnard's collection of negatives, kindly placed at our disposal, includes all of the objects we might wish to examine, taken with a Voigtländer doublet of practically the same focal length as our Zeiss doublet. By placing the spectrum plate on one side of the instrument and the direct photograph on the other, it becomes possible to detect the faintest traces on the former, and with attention to bring them into optical superposition with the direct pictures. It is an obvious elementary principle of spectroscopy that if the two images can thus be brought into superposition, the nebula (or those portions of it) must be yielding a discontinuous or gaseous spectrum. With a sufficiently bright gaseous nebula, of course a succession of images would be visible, corresponding to the different wave lengths of emission. With very faint objects only one image is likely to be sufficiently strong at a given focal setting of the prismatic camera.

The wave-length of the light forming the prismatic picture which we are examining may now be approximately determined. In turning the lever which opens one picture to view in the "Blink-Mikrometer" while it closes the other, there is an intermediate position in which both pictures may be dimly seen. In this position the numerous star images on the direct photograph will be seen to be sitting (as it were) on the numerous stellar spectra of the prismatic camera plate. The wave-length in any stellar spectrum of the point covered by the corresponding round stellar disk will be the wave-length of the nebular ray forming the objective-prism picture. The presence of the hydrogen lines in the stellar spectra will serve to identify roughly this wave-length. Thus we find that for the nebulae N.G.C. 6960 and 6992, as photographed with the prismatic camera focussed for the ultra-violet, the location of the star

images between the hydrogen lines would indicate that the principal radiation was at λ393. The spectra of these nebulae have been recently studied by Wolf at Heidelberg, but we do not lay our hands on printed statements about them.

Photographs of the nebulosity in the Pleiades indicated a continuous spectrum, but of course dark lines, if present, could not be detected by this method.

THE GENERAL MAGNETIC FIELD OF THE SUN.

By G. E. Hale, F. Ellerman, and A. van Maanen.

This paper describes a continuation of a study of the general magnetic field of the Sun, the preliminary results of which were given in *Contributions from the Mount Wilson Solar Observatory*, No. 71. The observed displacements of spectrum lines, which are attributed to the Zeeman effect, have been confirmed by the aid of Koch's registering microphotometer, which gives results free from personal equation. In *Contribution* No. 71 only four lines were shown to have displacements attributable to the Sun's magnetic field. This number has now been increased to eighteen, all of which agree in showing displacements of opposite sign, with maximum values near 45° latitude, in the northern and southern hemispheres of the Sun.

The list of elements represented by these lines includes iron, chromium, nickel, and vanadium. In two important papers on "Radial Motion in Sun-spots," Dr. St. John has shown that, on the average, lines of increasing intensity represent successively higher levels in the solar atmosphere. When the magnetic field-strengths determined for the lines observed in the present investigation are plotted against the line intensities, it appears that the field-strength decreases rapidly in passing upward through the solar atmosphere. At a level represented by chromium lines of intensity 6 the Zeeman displacements become too small for measurement.

SUN-SPOTS, TEMPERATURE, AND RAINFALL.

By W. J. Humphreys.

Many efforts have been made to show the relation or want of relation of sunspot numbers to rainfall and to temperature; especially have numerous investigations been made in regard to temperature variation, and indeed most of the careful observers have found that, on the whole, the temperature of the earth increases with decrease of sun-spots and decreases with increase of sun-spots; but in this general relation there

are numerous and confusing exceptions. When, however, variations in the intensity of insolation resulting from dustiness in the high atmosphere are taken into consideration, it appears that the agreement becomes surprisingly good; that is to say, the combination of sun-spot influence and our own atmospheric influence gives a curve that varies closely with average temperatures.

A careful analysis of the rainfall of Europe during the last half century, and a similar analysis of the rainfall over the eastern half of the United States, both show a variation that more or less follows sun-spot variation. When, however, the rainfalls of these two parts of the world are combined, their variation follows the temperature variation with remarkable fidelity. It is therefore the temperature changes which rainfall follows directly, and sun-spot variation only indirectly, through temperature. We can say, then, that in so far as our temperatures are influenced by the conditions of the Sun, that far and presumably no farther does rainfall also follow solar changes.

COLOR EQUATIONS OF PHOTOGRAPHS TAKEN WITH THE 16-INCH METCALF TELESCOPE.

By Henrietta S. Leavitt.

The color equation of any system of stellar magnitudes may be defined as the difference between the magnitudes of stars whose photometric magnitudes on the Harvard system are the same, but whose spectra are of classes *A*0 and *K*0, respectively. Thus the color equations of the Harvard and Potsdam visual systems are 0.00 magnitude and −0.27 magnitude, respectively, and that found by Professor E. S. King from measures of bright stars on photographs taken out of focus is +1.17 magnitude. The relative color indices of telescopes in use at Harvard are being derived by means of measures of the images of seventeen stars near the north pole, of which eight have spectra of Class *A* and nine of Class *K*. In the case of the 16-inch Metcalf Telescope, four different kinds of plates have been used, namely, Hammer Special plates, without screen (blue), Hammer Special plates with violet screen (violet), Cramer Isochromatic plates with yellow screen (yellow) and Hammer Special plates dyed with pinacyanol, using a red screen (red). The resulting color equations corresponding to violet, blue, yellow, and red light are +0.92 magnitude, +0.64 magnitude −0.23 magnitude, and −0.54 magnitude. The limiting magnitudes are 14.3, 15.4, 14.4, and 12.6, respectively, for exposures of ten minutes.

Comparison of blue and yellow plates gives an apparent difference, for *K* stars, of 0.9 magnitude while comparison of violet and red plates gives an apparent difference of 1.4 magnitude. It should be

possible to determine the color indices of the stars with great precision by employing violet and red plates. The blue and yellow plates have the advantage that they may be used for much fainter stars.

NOTE ON THE SPECTRUM AND RADIAL VELOCITY OF ψ PERSEI.

By Paul W. Merrill.

Twenty-one one-prism spectrograms of the bright line star ψ *Persei*, show no evidence of variable radial velocity. The similarity of the spectrum to that of ϕ *Persei* is not borne out in this respect. K yields a velocity accordant with that from the hydrogen lines.

THE OBJECTIVE OF THE SPROUL TELESCOPE.

By J. A. Miller and R. W. Marriott.

Professor Miller and Marriott discussed the quality of the 24-inch objective of the Sproul telescope as determined by a test according to the Hartmann method. The test was for 164 isolated points arranged on 24 zones. Hartmann's Characteristic quantity T was found to be

$$T = 0.068 \text{ by Marriott's measures}$$
$$T = 0.086 \text{ by Miller's measures}$$

The greatest discrepancy in the focal length of any two zones was found to be about 1.1 millimeters.

THE LOCATION OF THE FRAUNHOFER LINES.

By S. A. Mitchell.

The determination of the depths of the reversing layer is of the utmost importance in testing the various theories of the formatian of the Fraunhofer lines. Measures of 2841 lines of the flash spectrum* obtained at the 1905 eclipse give wave-lengths which differ, on the average, but 0.02 Å from Rowland. For each line is given also the height of the vapor forming the line, which heights were readily obtainable by measuring the lengths of the lines of the spectrum, which was taken without a slit. It was found that the majority of the lines are formed in a reversing layer 600 km in depth, but that the stronger lines extend much higher than this, H and K being found at heights of 14,000 km.

In order to find the average heights to which the various vapors extend, the elements were divided into three groups as to kind and four

* Ap. J. **38**, 486, 1913.

as to intensity. The following table is for the lines of lower intensity. Two other groups of intensities 6 to 10 and greater than 10 are not shown.

Elements	Rowland Intensity 2 or less				Rowland Intensity 3 to 5			
	Tot. No. of lines	Av. Intensity Rowland	Flash	Av.Ht. km	Tot. No. of lines	Av. Intensity Rowland	Flash	Av.Ht. km
Fe, Ni, Co, Mn	240	1.26	1.07	338	243	4.18	1.82	405
Ti, V, Cr, etc.	275	1.07	1.30	385	132	3.75	4.20	584
Rare Earths	150	0.82	3.10	417	29	3.59	6.16	783

The relative intensity of the flash lines compared to Rowland and the height in the reversing layer increases successively in the three groups. This is clearly shown for both classes of intensity.

The bearing of the results on the theories of Abbot and of St. John was discussed. The question of the intensities of spectral lines is a bigger one than can be solved simply by measuring the thickness of the layer of vapor producing these lines.

MEMOIRS ON THE THEORY OF ORBITS.

By F. R. Moulton.

The principal features contained in this paper are:

(1) The geometrical and dynamical conditions upon which the problem depends are directly and simply applied so as to secure generality and not to introduce any artificial difficulties.

(2) The degree of the partial indetermination of the problem, which is always one of its characteristics when the time intervals are short, is determined at the beginning; and, on the basis of this, it is shown how to limit correspondingly the number of places in the computation without sacrificing real accuracy.

(3) A complete analysis is given of the cases in which the result is altogether indeterminate.

(4) It is proved that the apparent motion can not be permanently in a great circle unless the observed body moves in the plane of the ecliptic.

(5) A strict analytic solution of the problem is given, though it is not recommended in practice.

(6) Numerical illustrations of the matters discussed and the method of computing an orbit (not the analytical) are given.

The paper will be published in the Astronomical Journal.

WENDELL'S PHOTOMETRIC MEASUREMENTS.

By E. C. Pickering.

Professor Pickering gave a brief description of the photometric observations of the late Professor Wendell. These observations were made with the photometer having achromatic prisms, attached to the 15-inch equatorial of the Harvard Observatory. The observations from 1892 to 1902 are already published in Part I of Volume 69 of the *Harvard Annals*. The later observations are now nearly all in type. They include measures of numerous variables; of asteroids, especially Iris, Eunomia and Eros which are variable; of eclipses of Jupiter's satellites; of the satellites of Saturn, Titan and Iapetus. The light curves in all these cases are surprisingly smooth, showing that the instrument employed is capable of furnishing results of a high degree of accuracy.

THE ARLINGTON TIME SIGNALS IN OMAHA.

By William F. Rigge.

This paper described an inexpensive but effective antenna construction for receiving the Arlington time signals, as well as various methods of comparing them with the home clock. See P. A. **21**, 626,1913.

ASTRONOMICAL PANORAMIC VIEWS FROM A CITY OBSERVATORY.

By William F. Rigge.

This paper presents a series of panoramic views from the Creighton University Observatory with altitude, azimuth, hour and declination lines drawn on them for every five degrees. Their purpose is to accustom students to the circles of the celestial sphere and to the magnitude of circular measure.

THE MOON'S MEAN LONGITUDE 1908-13

By Frank E. Ross.

Sixty-four occultations of the moon observed at the U.S. Naval Observatory in the interval April 1908 to November 1913 have been discussed with the object of obtaining the moon's mean longitude. The tabular longitude is Hansen's, corrected by a mass of periodic terms, 86 in number, resulting from the researches of Newcomb, Brown, and Hill.

The results indicate that Newcomb's long period empirical term now fails to represent the moon's longitude. In 1910 the error was 3.″7, in

1913, 6″.9, the moon being ahead of its predicted position. The addition of the short period empirical terms computed by the writer (*Monthly Notices* 72, No. 1) does not improve the representation. The moon is deviating from its predicted position at such a rapid rate that a prediction even two years in advance may be liable to considerable error.

A study was made of the probable error of a determination in the moon's longitude from a single occultation. By comparing individual values with a smooth curve for the period 1908-13, the probable error was found to be ±0″.78. Three nights were selected from the mass of occultations collected by Newcomb, A. P. Vol. 9, on each of which a large number of occultations were observed, and the probable error computed for each night. The mean result was ±0″.92. The approximate equality of these two probable errors shows that the moon is not subject to short period irregularities.

ON THE CEPHEID TYPE OF VARIATION.

By Henry Norris Russell.

Some of the theories which have been advanced to account for the variability of stars of the Cepheid type assume that such stars are brighter on one side than on the other, and that much, if not all, of their variation is due to their rotation. This hypothesis may be tested by the method of harmonic analysis.

The light of any such variable may be represented by a series of the form

$$L = A_0 + A_1 \cos(\theta + \alpha_1) + A_2 \cos(2\theta + \alpha_2) + \ldots$$

where θ has the period of the light variation. These series have been determined for five typical Cepheids whose light-curves are particularly well determined. In most cases the ratios of the amplitudes A_n of successive harmonics, and the difference of their epochs α_n are nearly constant for each star. The actual light of the star, and not its stellar magnitude, has been analyzed.

The light changes arising from the rotation of any convex spotted body can easily be reduced to those arising from that of a spotted sphere. If we assume that this sphere is dark, except for a narrow rim surrounding the invisible region about the pole which is turned away from us, any arbitrary light-curve may be reproduced. But if we assume, as is physically reasonable, that there is no essential difference between the nearer and remoter hemispheres, it is possible to show that with every harmonic term $A_n \cos(n\theta + \alpha_n)$ there must be associated at least a certain amount $R_n A_n$ of constant light.

If the sum of these quantities $R_n A_n$ exceeds the observed constant term A_0, the observed light variation can not be accounted for by the uniform rotation of a convex body with spots permanent in position and brightness, and equally distributed on the two sides of its equator.

This is the case for all five of the Cepheid variables investigated. It follows that either (a) these stars do not rotate uniformly; or that (b) they are not convex in shape; or that (c) the surface-brightness of at least a part of their visible surfaces changes during the period. There seems to be no doubt that the third alternative is preferable.

The same statements can be made regarding any variable star of this type for which the increase of brightness is less than one-fourth of the period; but the variation of such stars as ζ *Geminorum* can probably be represented as due to the rotation of a spotted body.

FAINT STANDARDS OF PHOTOGRAPHIC MAGNITUDE FOR THE SELECTED AREAS.

By Frederick H. Seares.

Photometric observations are now in progress with the 60-inch reflector of the Mount Wilson Solar Observatory for the determination of the photographic magnitudes of the fainter stars of the 115 Selected Areas on and north of the celestial equator. An absolute scale is established for each region by means of diaphragms and a wire gauze screen. The program for each area is as follows:

Exposure Times Min.	Apertures Inches	No. of plate
2	60, 32, 14, 9, 9, 14, 32, 60	2
15	60, 32, 32, 60	1
15	60, Screen, Screen, 60	1

Of the 460 plates required for the determination of the relative magnitudes, 325 have already been obtained; and of this number one-half have been measured and reduced. The results will be reduced to a homogeneous system by inter-comparison and comparison with the Pole.

An indication of the amount of material which will thus be accumulated is afforded by the fact that the photographs for ten areas ranging from 20° to 72° galactic latitude show 864 stars, an average of 86 per area. On this basis, the final results should include magnitudes for nearly 10,000 stars.

The probable precision of a single value of a magnitude, including scale errors, is of the order of 0.09 magnitude. As an average of four values will be available for each star, the mean probable error of a catalogue magnitude should be about 0.05 magnitude.

THE COLOR OF THE FAINT STARS.

By Frederick H. Seares.

Direct determination of the color-indices for the regions of the Pole and *S Cygni* indicates a gradual increase in the minimum index with increasing magnitude. The change is from -0.4 magnitude at the sixth to $+0.6$ magnitude at the seventeenth photographic magnitude. The balance of evidence is in favor of space absorption as an explanation of the change in color.

The observations are all photographic, absolute magnitude scales being established by the use of diaphragms and screens.

OSCILLATIONS IN THE PERIODS OF CLUSTER VARIABLES AND THE COINCIDENCE OF VISUAL AND PHOTOGRAPHIC MAXIMA.

By Harlow Shapley.

Observations with the polarizing photometer of the cluster type variable *SW Andromedae* reveal a definite oscillation of the times of the rapid rise to maximum light. This phenomenon is capable of being observed with an uncertainty not exceeding two or three minutes, owing to the steepness of the light curve—a change of nearly a magnitude in one hour. Within an interval of a few days the time of maximum, or rather the time of the whole increase from minimum to maximum light, is found to oscillate with a range of fifteen minutes about the mean predicted time. The variation is shown distinctly by a long series of unpublished observations made at the Laws Observatory in 1908. It may be periodic and will probably be found an important characteristic of many or all of the cluster variables. Already the oscillation has been found to exist for three other stars of the cluster type. Wendell's observations of *RR Lyrae* show a conspicuous variation of this nature. His 240 observations give 20 determinations of the time of the increase to maximum light. The amplitude of the oscillation is 24 minutes and its period, according to a determination by Professor Russell, is about 70 mean light periods, that is, 40 days. The more recent observations by Kiess and Townley at the Lick Observatory also show the oscillation for *RR Lyrae*, but they would indicate a greater amplitude and perhaps a longer period. The photographic observations of *SU Draconis* by Martin and Plummer seem to show a small oscillation; while the visual observations of *ST Ophiuchi* made at the Laws Observatory show an apparently periodic shift if the whole curve with a maximum amplitude of twenty minutes. The mean periods of all these stars, so far as is now known, are entirely constant.

The announcement by Kiess in a recent *Lick Bulletin* that the photographic maximum of *RR Lyrae* precedes the visual maximum by 2.7 hours (one fifth the whole period), has suggested the determination of simultaneous photographic and visual curves of cluster type stars. The plates have been made by Professor Dugan and the visual observations by the writer. The photographs of *RR Lyrae* have not been completely reduced but the first examination of them shows no marked difference in the times of visual and photographic maxima. The discrepancy, if it exists at all, does not exceed twenty minutes. We have similarly investigated *SW Andromedae* and find that the maxima observed visually and photographically are practically coincident.

THE DISCOVERY OF THREE NAKED EYE VARIABLE STARS.

By Harlow Shapley.

The polarizing photometer of the Princeton Observatory has been employed by the writer for the precise measurement of the light of certain spectroscopic binaries. Three new variable stars have been found.

ψ *Orionis.* The spectroscopic work on this star at Ottawa and Allegheny show that the velocity range is one of the largest known, that the apparent masses are large, and that both spectra are visible. The possibility of a high orbital inclination and of shallow eclipses is evident, The period is 2.52588 days. Both minima have been measured; the primary eclipse shows a range of about two tenths of a magnitude and the secondary of perhaps twelve hundredths The duration of both eclipses is at least five hours. The secondary comes about three hour earlier than the point midway between primaries, which is consistent with the values of the eccentricity and the longitude of periastron found by Plaskett, but the minima come nearly two hours later than the times predicted from his elements.

88 *d Tauri.* The orbits by Wilson and Harper and the latter's discovery of the secondary spectrum suggested this system as a possible eclipsing binary. The photometric observations (1400 settings up to the present time) have been difficult because of the color of the only comparison star available for this photometer. The minima have been measured twice each. The primary is nearly two tenths of a magnitude in depth, but the secondary is only a few hundredths. The period by Wilson, 3.57124 days, seems to be satisfactory.

Alcor. The spectrograms made at the Yerkes Observatory in 1907 indicated a very short period, but as yet no orbit of the star has been published. Two sets of spectral lines, too diffuse for measurement,

were seen on some of the plates. The photometric observations show a variation of one fourth of a magnitude. More than a thousand comparisons (i. e. 68 sets) have been made, but so far no clue to the nature of the variation or its period has been found.

SPECTROGRAPHIC OBSERVATIONS OF NEBULAE.

By V. M. Slipher.

Flagstaff spectrograms of nebulae show, (1) that the extraordinary velocity of 300 kilometers of the Great Andromeda Nebula is moderate compared with that of N. G. C. 1068, 4565, 4594, and certain other spirals, which have radial motions of the order of one thousand kilometers per second.

And (2) that the spectrum of HV 30 is peculiar, as it shows only hydrogen bright lines; "nebulium", hitherto so universally present, is not represented. This seems to suggest that "nebulium" may not be a necessary luminous constituent of the gaseous nebulae.

THE USE OF DIFFRACTION EFFECTS IN STELLAR PARALLAX DETERMINATIONS.

By Frederick Slocum.

In the photographic determination of the parallaxes of bright stars various devices have been used for reducing the size of the image of the parallax star to the mean size of the images of the comparison stars. Among these devices may be mentioned absorbing filter, occulting shutter, and rotating sector.

Another method of avoiding magnitude errors has recently been tried by the writer at the suggestion of Professor Grossmann of Munich.

A strip of paper about three-eighths of an inch wide, stretched across the outer surface of an objective, will produce a line of diffraction images of a bright star. The first or second pair of diffraction images of a first magnitude star, with an exposure of eight or ten minutes, will be of the same order of size as the images of the comparison stars. Two small symmetrically placed diffraction images may, therefore, be measured, instead of the large central image.

This method will probably give good results for the brightest stars, for some bright double stars with approximately equal components, and for wide pairs in which the components differ by at least four or five magnitudes. In the last case the diffraction images of the bright component and the direct image of the faint will be used.

In the case of double stars the paper strip may be placed parallel to the line joining the components; ordinarily it will be placed parallel to the equator.

STELLAR PARALLAXES.*

By Frederick Slocum and S. A. Mitchell.

The following list of parallax determinations from photographs made with the 40-inch refractor of the Yerkes Observatory was presented and discussed.

Star	Magnitude and Spectrum		Proper Motion	Relative Parallax	Probable Error	No. of Plates	Probable Error of 1 Plate	No. of Comp. Stars
30 ϵ Andromedae	4.5	G5	0".34	+0".042	±0".014	14	±0".037	3
37 μ Andromedae	3.9	A2	0.15	+0.005	0.007	16	0.017	4
Lalande 1966	7.1		0.64	—0.011	0.012	11	0.027	5
33 α Persei	2.2	F5	0.04	—0.008	0.011	14	0.029	4
Lalande 6888	8.2		1.40	—0.016	0.011	16	0.032	4
Lalande 6889	8.8		1.40	+0.010	0.008	16	0.024	4
Comp. to 6888-9	11.0			—0.012	0.006	11	0.013	4
46 ξ Persei	4.0	Oe5	0.02	—0.010	0.011	10	0.024	3
A. Oe. 4961	8.5		0.48	+0.094	0.007	13	0.022	3
37 ϕ^1 Orionis	4.7	B	0.01	—0.005	0.006	16	0.017	4
40 ϕ^2 Orionis	4.6	K	0.32	+0.010	0.011	14	0.029	6
Weisse 8^h 596	8.6		0.76	+0.018	0.010	10	0.018	6
2 η Coronae Bor.	5.6, 6.3	G	0.23	+0.073	0.014	14	0.031	4
4 ϵ^1 Lyrae pre.	5.0	A3	0.05	—0.003	0.005	15	0.012	4
fol.	6.7		0.06	—0.007	0.009	14	0.024	4
5 ϵ^2 Lyrae pre.	4.9	A5	0.06	+0.006	0.010	15	0.026	4
fol.	5.2			+0.012	0.008	15	0.022	4
16 Cygni pre.	6.2	F	0.22	+0.043	0.008	15	0.023	5
fol.	6.3		0.20	+0.028	0.009	15	0.027	5
3 η Cephei	3.7	K	0.82	+0.066	0.010	15	0.027	6
Y Cygni	7 to 8			+0.001	0.010	14	0.019	6
61^1 Cygni	5.6	K5	5.20	+0.267	0.004	14	0.011	6
61^2 Cygni	6.3	K5		+0.277	0.006	14	0.017	6
23 ϵ Cephei	4.7	A5	0.46	+0.060	0.009	8	0.019	5
BD 28° 4562	8.5		0.75	+0.055	0.011	14	0.020	4
Oxford 28° 68304	11.6		0.59	+0.049	0.009	12	0.016	5
35 γ Cephei	3.4	K	0.17	+0.066	0.007	15	0.018	6
85 Pegasi	5.8	G	1.30	+0.084	0.010	14	0.020	4

THE TRANSMISSION OF TERRESTRIAL RADIATION BY THE EARTH'S ATMOSPHERE IN SUMMER AND IN WINTER.

By Frank W. Very.

Transmission curves for variously inclined rays were obtained by dividing the observed radiation to the sky by the unobstructed radiation to space appropriate to the observed surface temperature, assuming that space is at absolute zero, and calibrating the apparatus by readings on a black surface of cavernous shape at known temperatures, using Stefan's law. The radiation was received by, or emitted from the blackened surface of a delicate thermopile at the center of a hemispherical mirror which returned any reflected rays for repeated absorption.

* *A. N.* 4709.

ADOPTED VALUES.

Altitude above horizon	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transmission (summer)	0.116	.162	.190	.208	.226	.238	.249	.256	.262
Transmission (winter)	0.344	.415	.459	.495	.525	.543	.560	.572	.581

The vertical transmission obtained by observations of the zenithal sky radiation in equivalent small calories (sq. cm. min.) follows:

Winter surface temperature	263.7° Abs.C.	
Summer " "	291.3	
Winter effective temperature of zenithal sky	212.2	
Summer " " " " "	269.9	
By Stefan's law	Winter	Summer
Terrestrial radiation (unabsorbed)	0.3819	0.5685
Radiation of zenithal sky	0.1601	0.4196
Difference	0.2218	0.1489

Transmission (winter) =0.5806; (summer) =0.2619

The smaller summer transmission, in spite of the greater potential radiation of the hotter surface, is to be attributed to the presence of a larger amount of aqueous vapor in summer air. The ozone band at 9.1μ to 10μ was found to absorb about three per cent of radiation of longer wave-length than 6μ, and in summer less than this. Consequently, the presence or absence of ozone can not have much effect in causing variations of transmission of terrestrial radiation. An average transmission of 42 per cent is indicated for temperate latitudes. Attention is called to an ambiguity in the term "terrestrial radiation", as inferred from nocturnal cooling, in that a portion of the heat removed from the surface by convection is afterwards radiated by the air, and if undiscriminated, this causes a discrepancy.

REPORT OF COMMITTEE.

REPORT OF THE CHAIRMAN OF THE COMMITTEE ON PHOTOGRAPHIC ASTROMETRY.

BY FRANK SCHLESINGER, CHAIRMAN.

I. *Experiments with Wide-Angle Cameras.* Experiments are in progress at the Allegheny Observatory to ascertain what are the advantagees and disadvantages of the wide-angle camera as compared with the meridian circle for the determination of the positions of faint stars in zones like those of the Astronomische Gesellschaft Catalogue. The results of these experiments so far as they are completed up to the present are embodied in a paper by Schlesinger and Hudson soon to be published. This work is to be continued at the Allegheny

Observatory on a larger scale. It is the intention to photograph in duplicate all stars (except some that are highly colored) down to visual magnitude 9.2 within 2° of the equator. The positions thus obtained should enable us to answer definitely many of the questions concerning accidental and systematic errors, and also concerning the economy of the method.

The camera with which these plates are being taken is attached to the mounting of the Thaw (30-inch) Refractor. The objective for this telescope is not complete but both disks have now been successfully manufactured and it is expected that the objective will be in place and in use by August, 1914. For this reason an effort is being made to complete the observing as early as possible; since, after the date named, it will no longer be feasible to employ the wide-angle camera in its present position.

II. *Experiments with a Stationary Telescope.* The nature of these experiments has been described in former reports. For the reason just stated not as much progress has been made with this work as would otherwise have been the case. But all the plates secured last winter have been measured and preliminarily reduced. These reductions show that a pier mounted in this way remains at least fairly stationary during the course of a night; and that if one were content with a moderate degree of accuracy the method proposed by Pickering would probably succeed. Possibly a high degree of accuracy can be attained with this method: this question can better be answered after the definitive reduction of these plates is completed, and it may turn out that it would be wise to repeat this experiment at a site selected especially for this purpose.

At the meeting of the Astronomische Gesellschaft held at Hamburg in August, 1913, six of the members of this committee happened to be in attendance. Advantage was taken of this fact to hold a meeting of the Committee. The following resolution was passed:

"While welcoming contributions toward the solution of the problem of fundamental places by photography, the Committee proposes for the present to deal principally with the problem of obtaining differential places of stars fainter than the eighth magnitude by photography; in the belief (founded upon results already obtained) that the time has come to supercede the plan of observing them visually with the meridian circle."

This resolution met with the approval of all the members who were present; namely, Backlund, Campbell, Pickering, Russell, Schlesinger, and Turner.

REVIEW OF SUNSPOT OBSERVATIONS MADE AT ALTA, IOWA, DURING THE PAST SEVEN YEARS, 1907 to 1913.

DAVID E. HADDEN.

The following brief review of the observations are in continuation of those contributed to POPULAR ASTRONOMY at irregular intervals during the past fifteen or more years, the last being for the year 1906 and published in this journal No. 150.

During the last five years of the present series the sun has been observed on an average of only about 150 days in each year. This was owing to the writer's having been appointed by the Governor as a member of the State Pharmacy Board and the duties of the office called him out of town frequently. The instruments used were a 5½-inch refractor and occasionally a 9½-inch Brashear reflector.

1907

This year was remarkable for the number of large spots which were visible, every month witnessing one or more "greater" sunspots. Those of February and June were of giant size and nearly equalled those of the previous year. In October four large groups were observed and one increased to a train of very large spots of tremendous extent which made a second transit only slightly reduced in extent in November.

1908

Decreasing activity which set in during the closing weeks of 1907 continued during the first three months of this year, but a revival took place in April and some fine spots were seen, but the greatest activity of the year occurred in August and September, the giant spots being easily seen with the naked eye. Diminishing activity and some spotless days marked the closing months.

1909

There was only a slight reduction in the average monthly numbers of groups, spots and faculae this year as compared with those of 1908. Large spots were present on the disk nearly every month, the exceptions being June, August, November and December. By far the most interesting spots of the year were in September, when large and active ones were present and on the 25th remarkable electro-magnetic disturbances were noted in the daily papers as existing all over the United States and Great Britain, interrupting telegraphic and telephonic service.

1910

A marked decline in numbers of groups, spots and faculae was noted this year, and the number of spotless days greatly increased.

The months of February, May, September and October recorded the largest and most interesting groups, those of September and early October being of the train or stream character and of great extent. The closing two months of this year registered the least number of spots for a longer continued period than any other of the present cycle.

1911

The quiescent period noted above continued almost all of this year. At no time of observation, with one exception in April, were there more than two groups of spots present on the disc and all were relatively small, fully one-half the total number of days of observation revealing an absence of dark spots.

1912

This year like the preceding one was very quiet, nearly three-fourths of the days being free of spots. The faculae also showed a marked diminution and the actual minimum of the cycle near at hand.

A few of the larger spots were traced during several rotations; that of March 8 reappeared early in April and was spectroscopically active and increased to a considerable group. It reappeared for the third time early in May as a train of small dots and was last traced during the closing days of May. A typical normal spot was present in June and some of the two-spot variety in October and December.

1913

This year undoubtedly marked the end of the minimum period, which must have been passed by the middle of the year, although it has been prolonged so much that it may be difficult to locate the period precisely.

A small spot with outliers was seen in high north latitude about February 23, which may mark the beginning of the new cycle. Some dots also in the same latitude in July would indicate that the forces originating the new cycle of activity were already at work. Eighty-five per cent of the observing days were devoid of spots.

Reviewing the writer's own observations during the last twenty-three years, which embraced two maximum and two minimum periods, the following dates have been derived:—

Minimum of 1889.6 to maximum of 1893.7 = 4.1 years,
Maximum of 1893.7 to minimum of 1901.5 = 7.8 years,
Minimum of 1901.5 to maximum of 1905.9 = 4.4 years,
Maximum of 1905.9 to minimum of 1913.5 = 7.6 years,

Minimum of 1889.6 to minimum of 1901.5 = 11.9 years,
Minimum of 1901.5 to minimum of 1913.5 = 12.0 years,

Maximum to maximum = 12.2 years.

The annual results of the period under review are as follows:—

Years	Number of Observing Days	Average number of			Spotless Days	Percentage of Spotless Days
		Groups	Spots	Faculae		
1907	205	3.8	15.8	3.4	0	0.0
1908	231	3.4	13.0	3.4	4	1.7
1909	121	2.9	12.8	2.9	5	4.1
1910	171	1.3	5.0	1.9	45	26.3
1911	156	0.62	1.64	1.02	77	50.0
1912	150	0.36	1.75	0.67	104	69.4
1913	159	0.14	0.60	0,30	135	85.0

In the following tables are given the monthly summaries of the daily observations taken from January 1907 to December 1913.

Months	Number of Observing Days	Average number of			Number of Spotless Days
		Groups	Spots	Faculae	
1907					
January	8	5.2	22.2	4.0	0
February	12	6.5	29.0	3.7	0
March	16	4.0	13.4	3.6	0
April	13	3.3	13.5	2.8	0
May	15	2.5	8.0	2.9	0
June	22	2.0	10.2	3.0	0
July	26	3.2	13.4	2.9	0
August	23	4.0	13.5	3.0	0
September	13	4.8	21.7	3.8	0
October	22	3.7	17.6	3.6	0
November	20	3.2	16.3	3.8	0
December	15	2.9	10.9	3.2	0
1908					
January	22	3.3	13.3	3.3	0
February	11	2.3	6.4	3.4	0
March	16	2.7	8.0	3.1	0
April	18	3.9	15.5	2.8	0
May	20	3.1	9.1	3.0	0
June	21	3.3	12.6	3.1	0
July	23	3.1	12.8	3.4	0
August	24	4.5	22.5	4.4	0
September	26	5.4	22.6	3.8	0
October	16	2.4	6.0	4.0	4
November	16	3.3	14.4	3.2	0
December	18	3.3	12.5	3.3	0
1909					
January	10	4.6	18.8	3.3	0
February	9	4.0	21.2	3.7	0
March	7	3.3	20.0	3.6	0
April	12	1.8	6.8	2.4	2
May	9	2.3	11.5	2.4	0
June	16	2.4	7.4	2.8	0
July	13	2.5	10.2	2.5	2
August	19	2.3	8.0	3.0	1
September	13	2.2	10.1	2.5	0
October	7	4.1	14.0	3.3	0
November	2	...	...	...	0
December	4	...	...	...	0

Months	Number of Observing Days	Average number of			Number of Spotless Days
		Groups	Spots	Faculae	
1910					
January	4*	2·0	4.0	3.0	0
February	9	1.6	10.0	1.8	2
March	17	2.0	7.1	2.0	0
April	19	0.8	1.4	1.0	6
May	16	1.7	6.2	1.9	0
June	17	1.0	3.7	1.6	5
July	16	1.1	3.1	1.8	3
August	12	0.8	2.9	2.0	5
September	16	2.0	7.0	2.0	4
October	14	2.0	11.3	2.0	1
November	17	0.4	0.8	2.0	11
December	14	0.4	2.0	1.2	8
1911					
January	10	0.5	0.5	1.1	5
February	11	0.8	2.3	1.4	5
March	19	0.8	3.3	1.0	9
April	13	1.2	2.6	1.2	2
May	13	0.8	3.0	1.6	7
June	15	0.4	1.0	1.0	9
July	17	0.5	2.0	1.0	10
August	18	0.7	1.4	1.1	9
September	10	0.6	1.5	0.7	4
October	9	0.3	0.8	0.8	6
November	11	0.6	1.0	0.5	4
December	10	0.3	0,3	0.9	7
1912					
January	9	0.0	0,0	0.2	9
February	10	0.1	0.1	0.3	9
March	15	0.4	1.5	0.5	9
April	10	0.6	3.8	0.5	5
May	16	0.4	3.1	0.5	10
June	9	0.9	0.9	1.1	2
July	13	0.4	2.3	1.0	10
August	14	0.1	0.1	0.4	13
September	8	0.5	4.5	1.4	5
October	14	0.3	1.7	1.1	9
November	16	0.2	0.4	0.5	13
December	16	0.4	2.8	0.6	10
1913					
January	18	0.3	0.5	0.6	12
February	15	0.1	0.3	0.2	13
March	9	0.0	0.0	0.0	9
April	12	0.2	0.8	0.2	10
May	7	0.0	0.0	0.1	7
June	16	0.0	0.0	0.0	16
July	17	0.1	0.3	0.2	15
August	12	0.0	0.0	0.7	12
September	12	0.2	1.0	0.3	9
October	15	0.2	1.5	0.2	12
November	9	0.1	0.3	0.3	8
December	17	0.5	2.5	0.8	12

Observatory, Alta, Iowa.
January 12, 1914.

* The telescope was partly dismounted for repairs during the months of November and December 1909 and January 1910, hence the paucity of observations.

DRAWINGS OF MARS 1914.

LATIMER J. WILSON.

Mars has been observed here irregularly since June, 1913. One hundred and eleven drawings of the planet have been made from July 3, 1913 to February 2, 1914. Two or three a night is the usual number made at the telescope but on exceptionally fine evenings as many as six or seven drawings in color have been made. The drawings shown on Plate VII are copies from my observing book and are, with the exception of the first, all made on the same evening.

1. The region of the Mare Sirenum, November 17, 1913, at 19h 45m G.M.T. fine seeing, 350x, 500x and an attempt at 800x on the 11-inch reflector. Compare the dark area near the northern cap with the same as shown on drawing 8. A very white spot extended beyond the terminator near the equator. Three drawings were made on the evening of the 17th, and light spots were seen in this region from 18h 18m to the time of the illustration, when it was at its brightest.

2. The region of the Solis Lacus on February 1, 1914 at 11h 52m G.M.T. Fine seeing, 350x, 11-inch reflector. These markings, usually so faint that they are only seen with difficulty, came out quite strong against the daylight sky. Near the northern cap a strip of pearly white extended apparently across a "canal" which stretched diagonally toward the Sinus Aurorae. The only pure white was in places in the northern cap and a very narrow strip at the south pole. The border of the northern cap in all these drawings of February 1 was distinctly blue. The Solis Lacus is chocolate colored.

3. The same at 12h 25m, seeing not quite so good against a dark sky.

4. At 13h 52m, seeing fine. The Solis Lacus and Nectar rather difficult.

5. At 14h 52m, seeing fair. Note the large, white extension to the northern cap just coming into view.

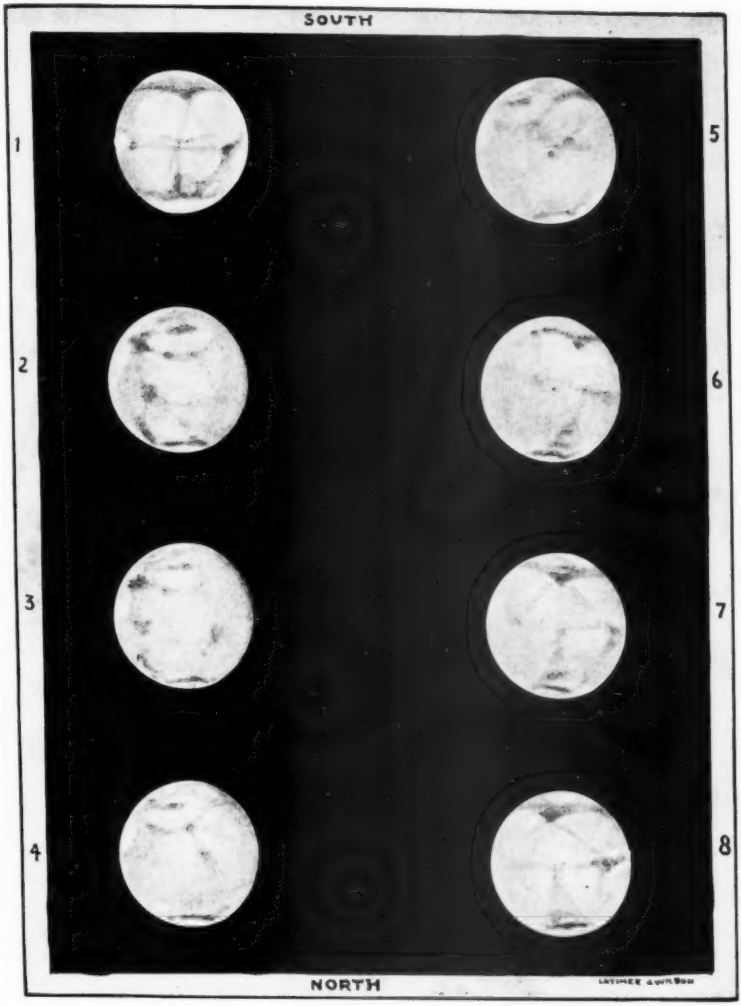
6. At 16h 37m, seeing fine. South of the northern cap is a light area, evidently what was seen in the other observation.

7. At 17h 45m, seeing fine. The light place south of the northern cap seems to be less conspicuous.

8. At 18h 30m, seeing fine. There is no doubt that the light area referred to above has darkened. It has also changed from pearly white to a rather light orange. I think it is frost or light snow which has melted with the advancing day.

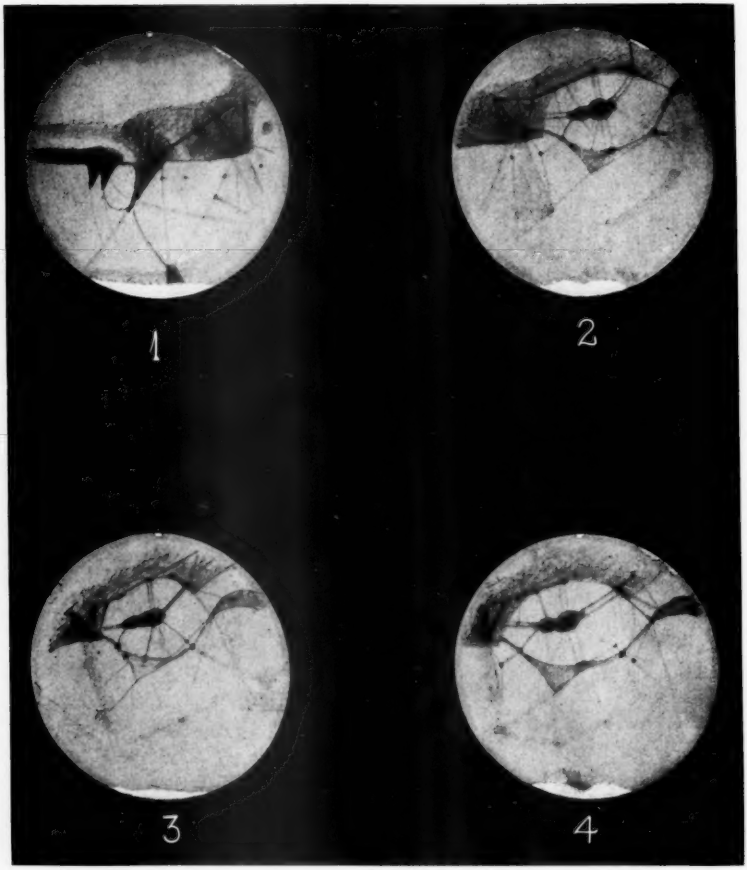
1405 Gartland Ave.
Nashville, Tenn.

PLATE VII



DRAWINGS OF MARS IN 1914, BY LATIMER J. WILSON.

PLATE VIII



DRAWINGS OF MARS 1911 MADE AT THE LOWELL OBSERVATORY.

1. Nov. 14, by E. C. Slipher
2. Nov. 6, by E. C. S.
3. Dec. 15, by Percival Lowell.
4. Nov. 14, by E. C. S.

THE MARTIAN MARKINGS.

E. C. SLIPHER.

It is my purpose in this discussion to present with fairness and justice to both sides, the data and evidence of consequence which has any bearing on the subject and the reader may judge it and decide for himself. I neither desire nor intend in my treatment of this subject to invite controversy of anyone, because personal controversies seldom if ever result in any scientific advancement of the point at issue—and for this reason only I shall avoid so far as is possible personal references.

My first extensive observations of Mars were made in Chile, S. A., at the time of the Lowell expedition to the Andes, with the excellent 18-inch refracting telescope of Amherst College. This was during the favorable opposition of 1907. There in the elevated and rainless desert waste of Tarapaca exceptional conditions of atmosphere prevailed, and with these the very small zenith distance of the planet combined to make the seeing extraordinarily good. The quality of the seeing was very constant, one night being much like another and when the planet was on our meridian, often times the optical disturbances due to our atmosphere were scarcely perceptible.

Although the primary object of this expedition was to make a photographic study of the planet, some time was given to visual observations by me, these interspersing photographic ones.

Prior to this I had seen Mars telescopically only a few times and on but two or three occasions through a large telescope. As the only observer with the expedition I made my observations alone, which precluded any chance of their being biased by the knowledge of what some one else was seeing. Furthermore, in view of the skepticism existing at the time concerning the canals, and in order that I might not be influenced, in the least, by the earlier drawings made by other observers or by preconceived ideas, I had purposely kept myself so far as possible unacquainted with the areography of the planet. Thus, any aid or influence I may have received in these observations could have come only from the numerous photographs I made. Therefore, the canals and oases and other details represented in my rather rough drawings were virtually re-discoveries.

Inexperienced in visual work on this planet and observing with conservatism and with unusually fine seeing, I saw in all 149 canals and many oases, during one presentation, between the approximate latitudes 45 N. and 55 S., this being as many as if not more than, were

seen at Flagstaff during that opposition. These markings seen by me were confirmed by observations made at Flagstaff at that and previous oppositions. Not only this but I saw at least three canals that had never before been seen. Aside from these new canals several were observed which had not been seen for several oppositions previous; three of these had not been seen since 1894. So it was with a beginner. (See Plate X).

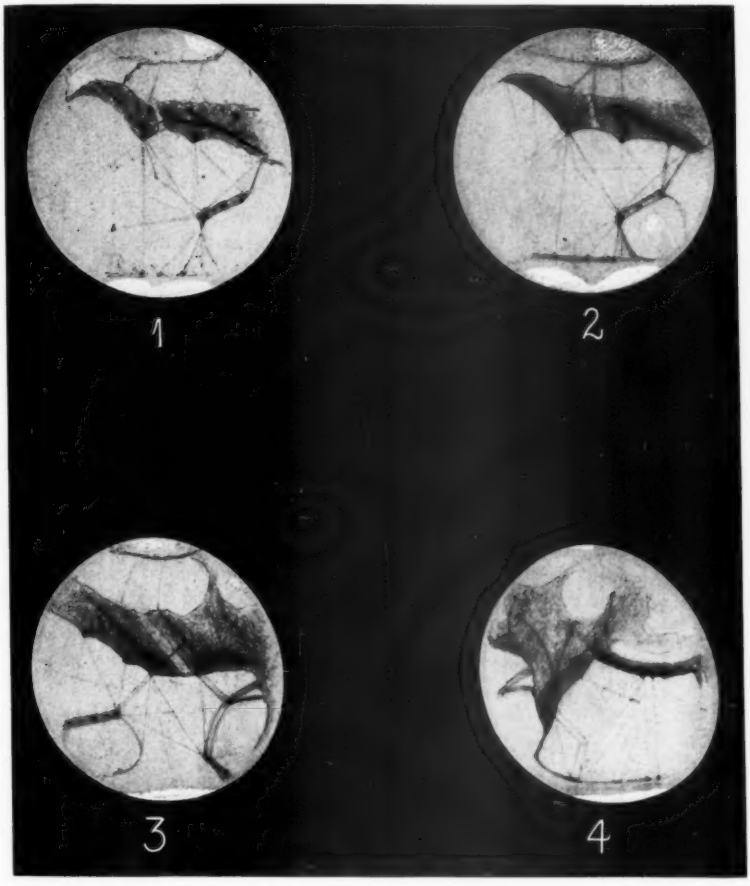
In making comparisons of the amount of detail seen at the two places, the difference in the altitude of the planet and its consequent effect upon the definition must be taken into consideration; the average zenith distance of the planet being about 4½° at culmination at Alianzia, while at Flagstaff it was 55½° lower.

At Alianzia the planet was observed visually and photographically from eight to twelve hours every night excepting two or three, between June 24 and August 1, when work began on dismounting the telescope. Different eyepieces were used for the visual observations giving magnifications varying from 240 to 810; the powers most used were 350 and 440. In most cases two different powers were used for the same drawing. On account of the almost vertical position of the telescope when the planet was near the meridian, some of the observations were made, in order to avoid bodily fatigue, with a reflecting eyepiece which of course reversed the image. Although the markings in these drawings are reversed in position their agreement with those made with the direct eyepiece is complete (See Plate X).

For the photographic observations different focal lengths for the camera system were tried, but the maximum obtainable with the lens at hand gave the best results. Cramer plates were used almost entirely, with a Wallace color screen. The exposure times were varied from about one and a half to nearly three seconds.

In all one hundred and eight complete drawings were made from visual observations by me, and a little over 13,350 photographic images of the planet were obtained. These photographs show not a few but a large number of the canals and oases observed visually, not only once but hundreds of times over, and always in the precise positions they have been given in the drawings. Now remember, reader, that the photographic plate records only realities; that all these show some canals and oases and in some of the best defined images of the Syrtis Minor region I have counted as many as twenty of them. With all this incontrovertible positive evidence, secured under the best possible conditions of seeing and with different telescope and accessories, corroborating the great mass of visual observations made by Lowell and others, can it be possible then that these markings are illusions?

PLATE IX



DRAWINGS OF MARS 1911 MADE WITH THE LOWELL REFRACTOR.

1. Dec. 5, by P. L.
2. Dec. 4, by E. C. S.
3. Jan. 1. by E. C. S.
4. Feb. 3, by E. C. S.

A few who show no desire to be convinced are still fostering skepticism by quoting and expounding various illusion theories, all of which have been clearly and absolutely invalidated by the photographing of these markings. Others, in order to create doubt, raise material or inconsequential objections to the observations and drawings and some even mislead their readers by unpardonable misrepresentations. Much of this so-called criticism comes from those having very little, if any, first-hand knowledge of the planet. Some of these skeptics quickly admit that the markings they are able to see exist in reality and then they absurdly contend that all the others are merely illusions.

In at least one instance doubt has been expressed that the polar caps of Mars change. Professor Harold Jacoby in his recent book, Astronomy—A Popular Handbook—has this to say of them: "The polar spots seem to increase in the Martian winter season, and to diminish in the summer. If so, they may be ice caps; and it is this notion that gives color to the canal theory." It is a well-known fact agreed to by the observers of this planet that they do change in this precise manner.

In a similar spirit he quotes Dr. Lowell on the Venus markings. Dr. Lowell has never seen on Venus canal or oases-like markings and where it seemed necessary, has so expressed himself always. In 1897 he saw on that planet markings having definite contours—contour presupposes extent of surface—and, perhaps due to difference in seeing, saw them less definitely outlined in 1906 but his opinion has never materially changed.

In the same book, the author lays much stress on what he terms the "reversal" of Professor A. E. Douglass and quotes his illusion theories to explain the canals. Let us inquire into all this. We find that Mr. Douglass during the oppositions 1892-1901, observing largely with the Lowell 24-inch refractor, pictured great numbers of these linear markings on Mars. Then sometime after involuntarily leaving this observatory and ceasing this class of work, he significantly but quite unnaturally endeavors to discredit the reality of the Martian canals. This he attempts to do, even at the cost of repudiating his own observations and deductions covering a half dozen oppositions, by inapplicable psychological illusion theories. Singularly he endeavors to invalidate his own work of years, destroying thereby the confidence it may have inspired, and seeks one's trust anew in some unsafe and insufficiently tested theories for illusion to explain these details.

I shall refer you to the original article by Professor Douglass in the Popular Science Monthly May 1907, for a free interpretation of his discussion.

As it was Professor Jacoby's desire to discredit the reality of the canals, it is natural to presume that he quoted the strongest obtainable statements in favor of his case, therefore I shall quote and discuss these first.

"The ray illusion is to me a very satisfactory explanation of many faint canals radiating from those small spots on Mars, called 'lakes' or 'oases'. The only objective in such cases is the spot from which they start. The reader will notice that rays on opposite sides of a star are usually in line."

"When a ribbon-like mark has a sufficient width, it must appear double.....If the planet is 16″ in diameter this will amount to nearly 10° on its surface."

Now let us inquire as to how he produced these ray illusions. He says they are seen by screening the greater part of the pupil of the eye by a small circular disk and allowing light from a black spot on a white background to pass through its margin. I have no knowledge of any eyepiece ever constructed on such principles and furthermore nothing connected with any of the observations ever made here or in South America could have produced such a condition or effect. Therefore this illusion theory is absolutely inapplicable to these observed Martian markings. But let us suppose that somehow it could be applied, then we would expect to see a similar series of illusory black rays emanating from each black dot seen on the bright areas of Mars or the other planets. Even then it would fail again to explain the canals for the oases are in general more difficult of detection than are the canals. Then, too, by simply rotating the eyes these illusory radiations would appear to rotate about the spot and their false character would be detected at once. Moreover, many canals are seen where no oases are visible. On still another count the ray illusion fails; it could not possibly explain any of the numerous canals visible in the dark regions of Mars. In Plate XI are reproduced some drawings of the planet by Professor Douglass that the reader may see for himself that the "ray illusion" theory fails to explain even the canals he saw, since in most cases the objective reality is absent.

The "halo illusion"—also quoted by Professor Jacoby as a means to explain the double canals—we see, is equally inapplicable and useless, because the width of none of the doubles falls within the width limits imposed by this theory. But if the theory did hold then none of the canals in the light regions of the planet would be seen double, but every one would appear tripled, and furthermore each oasis would appear within a ring. No such remarkable phenomena have ever been observed. For a further discussion of this see Mr. G. R. Agassiz in *Popular Science Monthly* for Sept. 1907.

PLATE X

DRAWINGS OF MARS 1907.

Those by Lowell were made at Flagstaff with the 24-inch refractor and those by Slipher were made in Chile, S. A., with the Amherst 18-inch.

1. July 29, by E. C. S.
2. July 24, by E. C. S. (Made with reflecting eyepiece)
3. July 26, by P. L.
4. July 23, by P. L.
5. Aug. by P. L.
6. June 30, by E. C. S.

In his arguments Professor Jacoby says further: "Now it is important to remember that imperfections of atmosphere, such as clouds, and all imperfections of the telescope, generally tend to diminish or destroy possibility of vision, but those of the eye and imagination if they act are just as likely to increase the number of details we think we see," etc.

Naturally these imperfections mentioned above impair the "seeing" but it should be noted that after investigating atmospheric conditions at many other places this observatory was located here (elevation 7,250 ft.) because of the absence of these imperfections, and also that the 24-inch refractor is unusually free from imperfections, as the Hartmann tests show (the best of any large lens yet tested). Therefore if he reasons correctly, it is obvious that imaginative details or illusions would be reduced to a minimum. So he has, inadvertently, only brought forth additional testimony to substantiate what he wishes and endeavors to disprove—the reality of the details observed here.

Then regarding the imagination versus training and experience the same writer states: "This theory explains why highly experienced observers see so much more than beginners. We are very proné to see what we are told by others is visible: we think we see what we desire and hope to see; do what we will we cannot prevent this."

Here again I cannot subscribe to his line of reasoning and deductions. If all this were true then the great achievements in the science of bacteriology, medicine or what not, can be attributed equally well to the same causes, errors of vision; for here too the scientist, trained and usually highly experienced, prepares his slides and examines them under a powerful microscope, prone to see what, perhaps, he has been told by others is visible or what he desires and hopes to see; then he too has seen, not the anticipated bacteria or disease germ, but what he could not prevent, an illusion. The one deduction is quite as sensible as the other. The immaturity of his arguments is obvious. He would have us believe that the first tyro is better than our trained and experienced scientists.

But whatever the effect of this rule he gives for the action of the imagination, if it did work, it must of necessity work equally well both ways; if it enables those to see who desire and hope to see, then it must prevent those seeing who desire not to see.

Surely we all know when we see any object certainly and when uncertainly; when it may be a ghost, when it is a reality. Quite naturally there is a limit to distinct vision, varying with the individual eye, beyond which doubt creeps in, but our intellect should and does warn us when that limit is reached. With good conditions of seeing the most of the Martian markings are not particularly difficult objects of vision to the keen and practical eye. Moreover a canal that is faint at one

time proves unmistakably strong at another season, thereby confirming its weaker self. Furthermore if these markings were illusions due to defects of any character is it not strange that we do not see them in increasing numbers when the "seeing" is poor, for then the imperfections of vision approach the maximum and the chance of seeing illusions would be greatly increased? The truth is that the markings become visible with favorable conditions of seeing and the better the conditions of atmosphere the greater the number and the better they are seen. Moreover, if they are illusions due to any cause whatsoever, whether defects due to atmosphere, to telescope, to the human eye or what not, then they should have been seen by some one at some time on some or all of the planets. But these characteristic features have been seen only on the image of Mars.

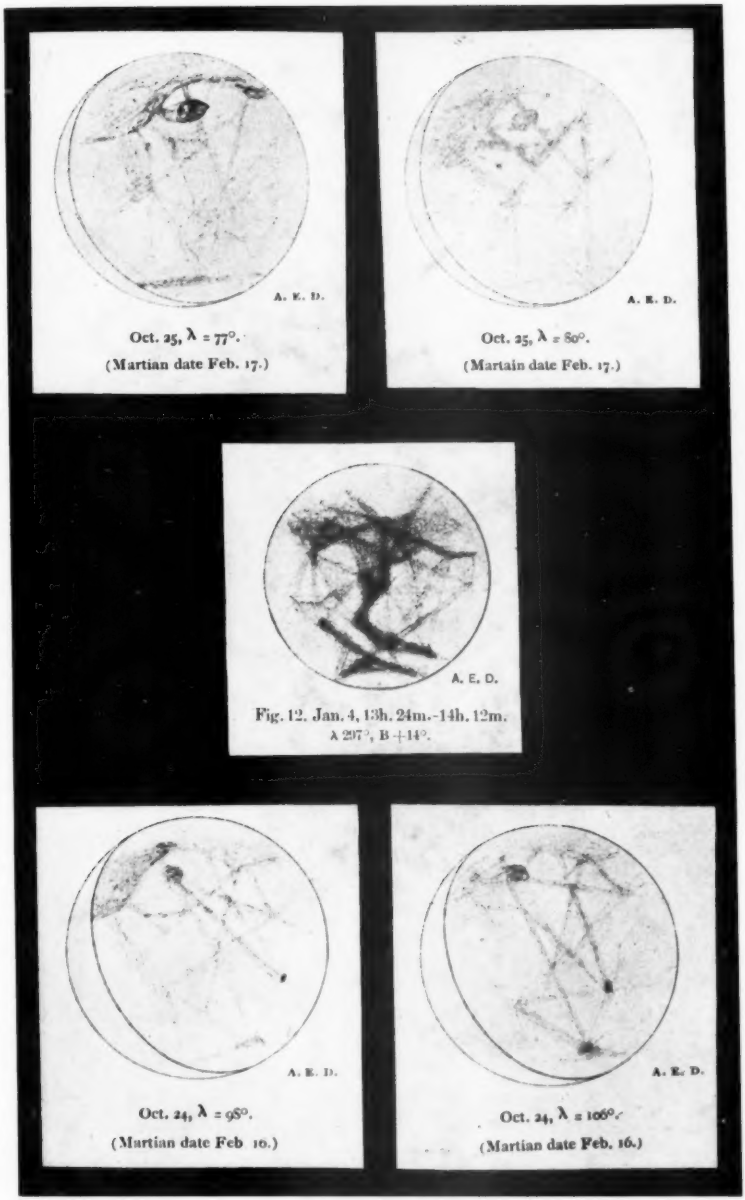
My South American observations, made as a beginner and alone, should furnish sufficient proof that these markings are not illusions seen only as the result of training and experience but, rather, that they are realities seen with good seeing sometimes in spite of these important prerequisites.

The truth is, illusions are not highly probable things as some seem to think but on the contrary, in actual practice, to the trained they are found to be very highly improbable if not almost impossible. Experience enables some to stamp the real from the fictitious at once and the trained observer does this unconsciously. It is understandable why one inexperienced in this study would fear the chance of seeing illusory details but practical experience in these observations will suffice to prove that such a fear is unwarranted.

Practical tests at the telescope are far better than any amount of theory or reasoning and if those who expound and advocate theories of illusion to explain planetary details would try practical applications to see where their theories lead, few would be made public. Most ideas of illusion have been investigated here and they have all been found defective or inapplicable both by experiments and by the observations themselves.

As a matter of fact all of these details, even the faintest canals, defy explanations as illusions. This is evident for two reasons: First because they bear the same stamp of reality as the obvious details; secondly, because a canal that is at one time quite faint becomes at another period so markedly intense as to rival in visibility any detail on the planet. As striking examples of this might be mentioned the Nectar and Thoth and others. Aside from this, inasmuch as the canals do not fall into distinct classes as regards intensity but are of all grades of visibility, then if one is cast with the false or the real, others of the same perceptible degree of visibility must be so classed accordingly

PLATE XI


A. E. D.
Oct. 25, λ = 77°.
(Martian date Feb. 17.)
A. E. D.
Oct. 25, λ = 80°.
(Martain date Feb. 17.)
A. E. D.
Fig. 12. Jan. 4, 13h. 24m.-14h. 12m.
λ 297°, B +14°.
A. E. D.
Oct. 24, λ = 95°.
(Martian date Feb 16.)
A. E. D.
Oct. 24, λ = 106°.
(Martian date Feb. 16.)

DRAWINGS OF MARS 1897 AND 1899 MADE BY A. E. DOUGLASS AT THE LOWELL OBSERVATORY. DRAWING IN CENTER ONLY WAS MADE IN 1899.

POPULAR ASTRONOMY, No. 213.

for the same reasons and so on until in the end one of two alternatives is reached and forces acceptance; that they are all false or all true markings. So there is only one possible consistent conclusion and that is that they are in their entirety realities.

Devise all the schemes and theories, optical, psychological or others you will, and you cannot explain away these numerous and remarkable surface features on Mars.

With good seeing, good eye-sight and moderate optical power, these Martian details are not especially difficult objects of vision, and the remarkable concordance of the results obtained by all the many observers who give time to this planet, goes further to prove that they see true details. True it is that some see more than others, due to different conditions for observing and to the individual eye, but they all concur beyond question in the details they do see. It is a significant fact that those who have sought out the best atmospheric conditions are seeing these details in the greatest numbers.

Acquaint yourself, if you please, with this observational evidence and you will find that it is confirmatory.

Perhaps proportionately less discrepancies, and certainly no more, occur in the drawings of this planet than those of any of the others, yet the reality of equally difficult markings observed, for example, on Saturn or Jupiter are not questioned.

It appears unfortunately that much criticism is born of the heart and not the mind. The crux of the situation is, it seems, that those who wish to discredit the existence of these Martian details will not make the conditions possible for their visibility.

It is not necessary to employ any particular device or to follow any special rule in order to see the "canals" and "oases" any more than these are necessary for successful work on the other planets, but if a few principles affecting the observation of planetary detail in general be observed more success will be obtained. The prime factor is of course good atmospheric conditions; second only to this is the importance of eyesight. The imperfections of the atmosphere are always present to a greater or less degree and it is the disturbance of the image due to these that first and always limits what we see on the planets, when a moderately large and good quality of telescope is employed. The problem is then to eliminate so far as possible the effect of these upon the definition. This can be accomplished to a greater or less degree, depending upon the size and character of the air waves producing the disturbances, by diaphragming the objective. Reducing the aperture by this means always proves beneficial but the effect is more marked on some nights than on others, due to a difference in size and character of the disturbing air waves. The most effective

aperture depends upon the planet and subject under study and is further determined by its consequent effect on the loss of light and the increase of the spurious disk; thus in practice its size becomes unconsciously a compromise between these factors affecting the definition. With a power of 400 on Mars the best results are given with apertures of 12″ to 18″.

Now the visual brilliancy of the disk of Mars, as our photographic study of the planets here shows, is about three to five times greater than for Jupiter and from twelve to fifteen times greater than for Saturn This excessive brilliancy of the image of Mars with large apertures not only affects the eye, but it also has a pronounced effect upon the definition and visibility of fine detail, because of the overlapping effect due to the greater size of the spurious disks of the points making up the bordering bright regions, caused by their increased brightness. By decrease in the brightness of these assumed points we reduce the size of their spurious disks with the result that the definition is improved. Thus the use of a dark glass over the eyepiece not only makes the light conditions more suitable for the eye but actually improves, markedly, the definition of detail. Because of the greater brilliancy of the image of Mars over that of Saturn and Jupiter and the fineness of many of the Martian markings, this improvement due to these tinted glass shades is more noticeable in the case of the former. Thus not only are the diaphragm and shaded glass correct in theory and principle but they are proven in practice to be important essentials to this kind of planetary work.

If telescopes of large aperture fail to reveal the "canals" and "oases" to an observer of good eye-sight under proper conditions of seeing, it is due either to utter disregard of such principles as mentioned above or to insincerity of purpose.

The canals and oases have been seen here with both the 40-inch reflector and 24-inch refractor and with apertures anywhere between six inches and forty inches. They were also seen in South America with the 18-inch Amherst telescope, which is conclusive proof that they are not functions, either of reflector, refractor or of aperture. The planet has been observed by me under equally good conditions of seeing and on the same evening, with the 40-inch and the 24-inch telescopes. These observations were made in a perfectly natural manner and alone, and with the same assiduous search for detail, and the result was that more was seen with the 24-inch telescope than with the 40-inch. Moreover the markings were seen sharper and finer with the former instrument and the details along, or in the canals themselves, such as oases and little irregularities, were seen much better with the instrument of smaller aperture. While working with the 24-inch the iris diaphragm over the

objective, which works like the slow motion from the lower end of the telescope, was turned down to 15½ inches, which shows at that time what aperture proved the most effective.

In a recent issue of this publication appeared an article on the physical appearance of the planet Mars,* in which the author attempts to cast doubt on the observations of Schiaparelli and other observers who have obviously seen the planet best, but his comments in many cases prove to be either inessential, inconsistent or quite aside from the point. Of the many later observers who have seen the canals and oases he does not speak directly, but he ventures to call these men imitators of Schiaparelli. However, it is not surprising that he does not see these markings when it is remembered that he only occasionally observes the planet at the Meudon Observatory (533 feet above sea level), and he adds to the disadvantages of the atmosphere those caused by failing to use a dark glass or shade over the eyepiece and also by using the full aperture of the 33-inch objective. His published drawings bear striking evidence that he sees the planet poorly, not only on account of the absence of fine detail but because of the ill-defined appearance of the coast lines and other markings along the dark regions. As further proof of this point, the photographs of the planet made by the observatory here show many canals and oases where he sees nothing. So the importance of his remarks is more apparent than real.

The illusion theorists should have been silenced long since and forever by the photographs of these Martian features. They faithfully reproduce as many or more details than the average observer sees visually and their evidence corroborating the visual work stands above question.

In his consideration of the photographic observations Professor Jacoby says: ". . . we must mention one or two matters that are not well known to the general public. In the first place the size of a Mars picture made by direct exposure of a photographic plate at the focus of the Lowell telescopes is not larger than the head of an ordinary pin. From so small a picture we could not even hope to discover any details. Therefore we must enlarge it as much as possible; and there are two ways of doing this. The first is to place an enlarging lens in the telescope itself. Two disadvantages limit this method. First, it complicates the optical system of the telescope, with consequent loss of distinctness in the image; and secondly it makes the image on the plate less brilliant. Experiment has shown the greatest photographic enlargements that can be made in this way with the Lowell telescopes; and the negatives of Mars, including the most recent ones made in the Andes, never exceed three-sixteenths of an inch in diameter."

* Popular Astronomy Aug.-Sept. 1913.

Some errors occur in these statements of his which it seems best to correct, not because of their vital bearing on the practical limits and possibilities of the photographic observations, but more because they might create totally false impressions concerning the value of the planetary photographs. Stated briefly, the facts are: first, that actual photographs of Mars the size of a pin's head and smaller, made through the telescope, show both canals and oases; secondly, that the consequent loss of distinctness in the image due to the complication of the optical system because of the presence of the amplifying lens is not perceptible and in no way does it limit, practically, the size of the images; thirdly, that the greatest diameter of the negative images of the planet which can be made with the Lowell telescopes is not three-sixteenths of an inch but vastly greater and can be anything within the theoretical visual power of the telescope; lastly, instead of being "never larger than three-sixteenths of an inch in diameter" they usually are much greater than this.

The optical principles of the camera system are quite similar to those of the visual telescope and the actual performance of the former is quite as good as, if not better than, the latter. The amplifying lens of the camera system does not actually enlarge the already formed image at the principal focus of the large telescope, but instead, it catches the cone of light at some distance from that focus and refracts the rays to form, at their focus on the photographic plate, a larger image.

So by the shifting of the lens in or out, or by interchanging lenses of different focal lengths, the size of the image may be made whatever best suits the conditions, and as in visual work the size of the image is governed by the atmospheric conditions. The performance of the optical system is attested by the fact that a variation from the true focus of about eighteen-thousandths of an inch is perceptible.

The focal length of the camera system as it is usually used is about 167 feet. This gives an image of Mars on the photograph at its near approaches, of from four to more than six times the surface of the moon as it appears to the unaided eye. So the reader may judge for himself as to the size of the image.

True it is that we cannot photograph the planets as well as they can be seen visually, as all who are acquainted with planetary photography well know. This is due to the slight motions of the image over the plate during the exposure of about two and one quarter seconds, caused by imperfections of the atmosphere. In visual work the impression gained by the eye is made up of the details visible during the best moments while the impression on the photographic plate represents a poor average picture of the details visible during whole period of exposure. However, in spite of this handicap a majority of the canals

seen here have left their impression on photographs, and some of the double canals have also been photographed as such. About twelve or fifteen would perhaps be a fair average of the number of canals and oases visible on a plate of a single region of the planet. Thus a large number of the markings have been recorded, not once but many hundreds of times over, on the many thousands of photographs obtained here since the opposition of 1905 when Mr. Lampland first succeeded in photographing them.

As the case stands today the photographs furnish incontestable proof that the canals and oases are real markings on the planet's surface and that remarkable changes in the intensity of these occur from time to time. Also they record changes in the grosser dark features of the planet, the whitening of certain regions such as the Hellas, the occurrence at due times of frost-like patches along the sunrise edge of the planet in certain latitudes, indicating, because of their significant behavior, early morning frost, also the presence of white patches about the winter polar cap evidencing clouds, frost or snowfalls in the process of making a new snow cap, also the gradual waning polar cap in the summer hemisphere. Thus aside from their corroborative evidence, they form a faithful permanent record of the Martian phenomena, affording true and valuable comparisons as time passes.

The canals and oases cannot escape anyone observing under suitable conditions, and, if the study extends over a sufficient period of time, very marked changes in these features, such as have been seen take place, for example during the last four oppositions, in the Nectar, Bathys and other markings about the Solis Lacus, and in the Nepenthes, Triton, Thoth, Lacus Moeris, and Cyclops and others in both the Syrtis Minor and about the Elysium regions, will compel his attention. At one time these canals may be almost if not entirely invisible and at another so vastly intensified as to rival in visibility almost any feature on the disk.

So the question today is not of the existence of these peculiarly changing Martian features but rather of what truths they may reveal to us.

MONTHLY REPORT ON MARS.—No. 3.

WILLIAM H. PICKERING.

During the past month the meteorological phenomena exhibited by the planet have been less striking than heretofore. It therefore seems a suitable occasion to review what has been already observed, before proceeding to the study of the advance of vegetation, which will next occupy our attention. In our last report it was noted that we had opened correspondence with a number of observers scattered in different longitudes around the world, not only to secure information about surface details which had passed beyond our range of observation, but also for the mutual confirmation of observations and measurements. For this latter purpose we are now able to present some results kindly furnished by one of our nearer correspondents, Professor Douglass.

In Table I are given the measurements of the latitude of the southern boundary of the northern polar cap on various dates, as measured at the Harvard Station in Jamaica, and at Tucson, Arizona. The measurments were all made from drawings, and when the phase was noticeable, the outline of the snow was prolonged beyond the terminator to the dark limb. When several drawings were made the mean is taken. This method is practicable in the case of the northern polar cap, because it is concentric with the Martian pole. The Harvard drawings were all made with an 11-inch aperture and a magnification of 660, those at Tucson with an aperture of eight inches, and a magnification of 220 to 340, according to the quality of the seeing. Occasionally a magnification of 420 was employed. The drawings at the latter station were all made by Professor Douglass, but were measured and computed by his assistant Mr. Getsinger.

From a general plot of the observations it has been concluded that the polar cap increased in size at an average rate of 1° every five days until October. It then increased at a diminishing rate until November 2, corresponding to the equivalent date of March 5 of the terrestrial year, and reaching a mean latitude at that time of perhaps 57°. It then receded according to the same law, and at the same rate. During the advance, and for a large part of the recession, until towards the end of December, the fluctuations in size were quite marked, the lowest latitude reached as shown by the table, being 42°. After that the snow storms ceased, and clear weather generally prevailed in the northern hemisphere during the day time.

TABLE I.

LATITUDE OF THE SNOW CAP.

JAMAICA.

1913-4	Lat.	1913-4	Lat.	1913-4	Lat.	1913-4	Lat.
	°		°		°		°
Aug. 14	72	Nov. 28	61	Dec. 15	67	Dec. 31	65
Sept. 2	65	" 30	56	16	68	Jan. 4	66
" 30	67	Dec. 1	58	17	67	5	67
Oct. 12	58	2	60	18	66	6	56
19	61	3	62	19	64	10	61
30	52	4	59	22	65	15	73
Nov. 1	42	8	55	23	66	17	70
7	59	10	58	25	60	18	70
17	60	12	62	29	69	20	70
26	67	13	64	30	62	21	68

TUCSON.

	°		°		°		°
Dec. 22	66	Dec. 28	64	Jan. 3	62	Jan. 9	66
23	64	29	63	4	62	11	68
24	63	30	61	5	63	12	67
25	64	31	62	6	68	13	68
26	66	Jan. 1	64	7	65	14	68
27	67	2	66	8	69	15	66

The early observations were made in the latter part of the night, when the planet was quite remote, and are rather few in number. Indeed this portion of the investigation could have been conducted to better advantage two years ago, at the preceding opposition, had we been located here at that time. After November 26 more frequent observations were made, and these are further enforced a month later

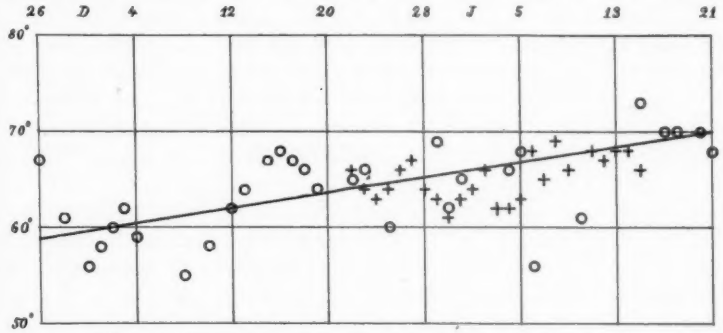


FIGURE 1, SHOWING THE VARIATION IN LATITUDE OF THE SOUTHERN BOUNDARY OF THE NORTHERN POLAR CAP OF MARS.

by those of Professor Douglass. These later observations are plotted in the curve Figure 1, those made in Jamaica as circles, and those at Tucson as crosses. The writer suspects that the smoothness of the fluctuations in the early part of the curve is in part due to accident,

since measurements made from mere drawings should hardly yield as accurate a result as the curve would seem to imply. Greater accuracy than later might however be expected, since the snow cap was wider.

It is not thought that the great extension of the snow cap noted at Jamaica on January 6 is due entirely to error. The definition was fair seeing 8, and the snow cap well seen. At Tucson the magnification employed on that and the two preceding evenings was 220, so that the planet appeared but one-third the size that it did in Jamaica. Indeed in the case of five out of the seven chief deviations noted between Jamaica and Tucson, a magnification of only 220, was used at Tucson, while in most of the accordant observations a higher power was used.

With two independent observers it is possible to obtain some idea of accuracy and reliability of the results. It was found that upon ten nights, observations had been secured at both stations. These are recorded in Table II, in which J stands for the observations made at Jamaica, and T for those made at Tucson.

TABLE II.

COMPARISON OF RESULTS.

1913-4	J	T	J—T	1913-4	J	T	J—T
	°	°			°	°	
Dec. 22	65	66	—1	Dec. 31	65	63	+2
23	66	64	+2	Jan. 4	66	62	+4
25	60	64	—4	5	68	63	+5
29	69	63	+6	6	56	68	—12
30	62	61	+1	15	73	66	+7

It is found from the last column that the Jamaica observations place the snow line just 1°, or rather less than 40 miles, north of the position determined at Tucson. A difference in this direction would naturally be expected from the larger aperture and higher magnification employed in Jamaica. That the difference should be so small is very satisfactory. The average deviation of the two observers from their mean is 2°.2 or 85 miles. This amounts to 1/50 the diameter of the planet, or 0″.3, which again is satisfactory, and quite as close as could be expected from measures of drawings. While some of this deviation is undoubtedly due to the irregularity of the shape of the polar cap, and to the fact that the observations were not made when the same meridian was central, yet it is thought that this source of deviation is comparatively insignificant, and that the chief cause of the difference between the results, after the accidental errors made by the observers is eliminated, is uncertainty of the exact extent of the snow, due to haze and cloud in the Martian atmosphere, near the limb and terminator of the planet. This would of course also affect micrometer observations, and cannot be avoided.

The dark band surrounding the polar cap, and produced by the melting of the snow, reached its maximum breadth of 25° in latitude during the first half of November, immediately after the polar cap had reached its maximum extension. Unlike the polar cap, however, it was eccentric with regard to the pole, its maximum breadth lying between longitudes 45° and 135°. It there closely resembled the southern *maria*, but differed from them in having only a brief existence. Its color was recorded as grey, not green. The appearance is believed to be due to moist ground rather than to vegetation; indeed, if our interpretation of the phenomena presented during a large part of these observations is correct, Mars might properly be described as the marshy planet. At present all of the polar marshes, with the exception of the Acidalium, are becoming lighter colored and are apparently gradually drying up.

The southern pole of the planet was heavily clouded throughout December, the cap being less brilliant, but much larger, and consequently more conspicuous than that at the north. The northern polar cap was due to snow. The cloud sometimes reached beyond the equator on the sunrise limb, but was very variable in extent, differing in that respect markedly from the northern snow cap. Except in high latitudes the Martian sunsets were clear. The polar clouds cleared for a time early in January, but were again conspicuous after the middle of the month. Clouds often gather on the northern boundaries of the dark regions of the planet. This was noticed on December 18 and 19, where even as small an area as Cerberus had a cloud on its northern edge. These clouds are often in continuous connection with the sunrise limb, and are evidently formed at night. They usually disappear by the afternoon. Clouds also often follow the polar marshes, but do not precede them, except in the case of the twin bays mentioned in the last report in longitudes 160° and 185°. In this case a cloud formed between them three days after they first appeared, and immediately covered and partially obscured the following one. The Acidalium Mare was frequently followed by a cloud, which on December 31 even reached the central meridian. These clouds serve very well to illustrate the fact that, as in the case of the earth, a considerable amount of moisture is transported often in visible form through the planet's atmosphere. On the whole, except at the south pole, clouds were less frequent than during the formation of the northern polar cap, but they now seem to be increasing again.

The amount of moisture in the atmosphere of Mars depends merely on the amount of water on the planet, and on the temperature. It is quite independent of the pressure, and of the other constituents of the atmosphere, and if these are rather rare, the atmosphere of Mars may be relatively much more damp than that of the earth. The chief effect

of the lack of the other constituents would be to cause evaporation and precipitation to occur more rapidly, and to cause a greater range of temperature, which would still further accentuate this result. This probably accounts for the long spells of cloudy weather near the pole turned away from the sun, that is the south pole in the present instance.

As the moisture is being distilled from one pole over towards the other, where it is being condensed, this should cause a strong northerly component in the Martian winds, much stronger than we observe in our own planet, where a large part of our atmosphere is inert. As the north wind from the pole spreads southerly in all directions through the lower layers of the atmosphere, it falls behind the more rapidly moving surface of the planet as it gets farther south, which explains why the mists rising from the polar marshes are always found on the following side.

Turning now to the changes in the surface markings, one of the most curious and interesting was in the case of the twin bays above mentioned. When first discovered, on December 16, the following one lay nearly along the meridian, the southern point being a little in advance, to the west astronomically speaking, or to the east as we would say if it occurred upon the earth. The next day it lay more nearly in the meridian, and the next exactly so. December 19 it was crossed by a cloud, but the southern point was now clearly following the northern end, and from day to day the inclination gradually increased. When last well seen, January 21, the change in the position angle amounted to nearly 30°.

An interesting illustration occurred this past month of the mutability of even what are usually considered among the most permanent features of the planet. On November 28 a drawing was made with the central meridian in longitude 55°. The northern boundary of the southern *maria* extended across the disk in an almost straight east and west line. The region clearly visible probably extended from about 0° to 110° in longitude. Not a trace of the forked bay of Sabæus, of Auroræ sinus, or of Solis lacus was to be seen. Margaritifer sinus was indicated only by a slightly projecting nub. In our last Report we described the sudden formation of Sabæus and Margaritifer, but no trace of Solis lacus appeared, the whole region south of Tithonius being uniformly dark. Our next view of this region was on December 25 when Solis lacus was perfectly distinct. Exactly what had happened in the meantime is only known to those observers on the other side of the world, in Australia, Asia, and the related islands,—provided they were on the watch for changes of this character. It is to obtain and publish information of this sort, that our chain of correspondents around the world has been established, and it is to be hoped that some of them

will have succeeded in collecting information upon this particular point.

A sudden and very striking change occurred in Protei regio, just preceding Solis lacus, a region which, as its name implies, is given to sudden changes. On December 30 it was drawn of a nearly uniform grey tint, but it was recorded that there was a lighter region in its interior, which is represented as a faint hazy marking lying in an east and west direction. The seeing was recorded as 12, which is as perfect as an 11-inch telescope is capable of detecting. The next night the interior contained two large lakes 200 and 300 miles in diameter, although not quite circular in form, and four well marked canals! Seeing 10, which is perfect for a 5-inch objective. The most plausible explanation of this change is that the effect was produced by the clearing away of a belt of cloud. Indeed this region seems now to have clouded up again.

The general character of these changes is a fading out of portions of the uniform grey surface, and the leaving of other portions in the form of canals, lakes, etc. In other portions of the planet however we find the dark regions advancing into the desert, showing that the desert so-called is not a desert all the time. Thus in December when Sinus Titanum and Sinus Sabæus both developed so markedly, it was not due to a retreat of the general coast line, but to an advance northerly of these two bays. Sinus Titanum is not marked on Schiaparelli's map of 1888, although the name was given by him. It is the northern point of the Mare Sirenum, and is one of the most important and clearly marked points upon the planet.

The so-called coast line or, more strictly speaking, boundary between the desert and the fertile region to the south of it, does shift in latitude in a very marked manner at times, especially at the promontories, that is the portions where it reaches farthest south. This has been very marked this year in the region preceding Sirenum. At present the whole of Libya is darkened, so that the Syrtis minor, which name Schiaparelli later changed to Syrtis parva, and which he represents as extending northerly to latitude $-10°$, now apparently extends to latitude $+10°$, a difference of some 800 miles. This darkening of Libya was one of the first changes noticed on the planet, and some of us may remember the mild consternation and deprecation expressed in astronomical circles some twenty-five years ago, when it was announced from Nice, by Perrotin, that the whole of Libya, a region larger than France, had been flooded!

Several of the smaller lakes and canals have now begun to appear in the desert regions. On January 8 it is recorded "there is a small, faint, ill-defined shading at A." "A" proves to be a point coinciding with Lowell's Sirbonis lacus, and is situated to the north of Sabaeus. Two

nights later three canals were drawn through this point, but they were described as on the "limit of visibility" and "only suspected". January 12 all were clearer, and they are recorded as "probably all genuine". The seeing was 8. This was our last observation of them, and it will be interesting to see how clearly they have developed when we see them at the next presentation in February. Although Sabaeus itself is now well developed. the point of Aryn between its two bays has not yet appeared. It is expected to be visible this next month.

Few color changes have been noted during the past few weeks. The northern shaded regions continue to be colorless, save the marshes, which near the polar cap are usually blue, while the shaded region, in the southern hemisphere continue to be distinctly greenish. On November 30 Sabaeus was described as grey, on January 6 as a clear chocolate brown, which latter color was confirmed January 11. This color was first noted in Cerberus December 16. It was not seen on the 18th, but was strongly confirmed December 19 and 22. It was also noted in the preceding of the polar twin bays December 22, while the following one is described as bluish and fainter. In the identification of the canals observed, such as do not appear on Schiaparelli's map are taken from Lowell's work, mostly from his chart of the planet in 1896-7, published in the Annals of the Lowell Observatory **3**, 100. These names are followed by an (L). Sometimes the canal observed does not agree either with Schiaparelli's nearest canal nor with that of Lowell; but lies between the two. In such cases it has not seemed desirable to the writer to give it a new name, but to identify it with whichever canal it most closely coincided. Other things being equal the earlier name is preferred. The writer is not prepared to question the accuracy of the other observers, but for various reasons feels doubt if a number of the less important canals are really fixed markings. That is if, when they do appear, it is always in the same place. He is rather inclined to believe that some of them shift about laterally over the surface, a shift which may amount to several hundred miles. In other words sometimes one area of the desert develops vegetation, and sometimes the area next to it.

Owing to a combination of circumstances comparatively few canals were observed in November. On the 7th we recorded in section **4** Nilosyrtis, Thoth, Eunostos, Achelous (L), and Hyblaeus.

Dec. 3. **6** Indus was glimpsed, but it was very vague.

Dec. 4. **1** Solis lacus, Nectar, Agathodaemon.

Dec. 10. **5** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Eunostos, Achelous.

Dec. 12. **5** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Cerberus. Eunostos, Hyblaeus, Achelous.

Dec. 13. **4** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Cerberus, Eunostos, Hyblaeus, Achelous, Pactolus, Styx.

Dec. 15. **4** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Cerberus, Eunostos, Hyblaeus, Achelous, Pactolus, Styx.

Dec. 16. **4** Cerberus, Eunostos, Hyblaeus, Styx, Hades.

Dec. 17. **3** Cerberus, Eunostos, Hyblaeus, Styx, Hades, Achelous, Pactolus, Noes (L), Brontes (L), Trais (L), Teren (L).

Dec. 18. **3** Cerberus, Eunostos, Hyblaeus, Styx, Anian, Trais, Tartarus. The last two were very faint, and only showed following and north of their junction.

Dec. 19. **3** Cerberus, Hades, Erebus, Trais, Brontes. All were broad and excepting the first faint. Brontes did not extend north of Trais. The whole region between Erebus and Hades was slightly darkened.

Dec. 22. **3** Cerberus. Hades, Erebus. The breadth of the last was 600 miles, that of Hades 400, but they were clearly separated by a light region which persisted, but may have been cloud. The length of these two canals was 2000 and 1300 miles. It might be questioned whether we could properly call such broad markings canals, but a month later their breadth was reduced about one half, and doubtless later will be reduced still further, so there seems no other course to pursue.

Dec. 23. **3** Cerberus, Eunostos, Hyblaeus, Styx, Hades, Erebus, Brontes, Trais, Teren. Only a very short section of Erebus was visible, the rest of it probably being concealed by cloud.

Dec. 24. **2** Our first glimpse this year of Solis lacus, as a small rounded spot about 300 miles in diameter. It was probably seen through a break in the Martian clouds. Seeing 6.

Dec. 25. **2** Solis lacus now appears as a narrow band 200 miles wide, and nearly 1000 miles long. Agathedaemon, Daemon (L), Araxes, Acampsis (L), Ceraunius. Acheron.

Dec. 29. **3** Only Cerberus was visible, although the seeing was recorded as 7. Later Erebus came out when the seeing was reduced to 6. The planet seems to have been covered by general Martian cloud or haze. Even the wider markings were faint, although sharply defined.

Dec. 30. **2** Solis lacus, Tithonius lacus, Juventae Fons, and an unnamed lake at the southern end of the Ambrosia canal that might properly be called Ambrosia lacus. Agathodaemon, Daemon, Nectar, Ambrosia (L), Baetis (L), Glaucus (L), Acampsis (L) Araxes, and two unnamed canals. The canals connecting Ambrosia, Solis, and Tithonius lacus with the preceding *maria* were quite broad, nearly as broad as the lakes themselves, but by the following night they had appreciably narrowed. Seeing 12 and 10.

Dec. 31. **1** The lakes visible were Ambrosia, Solis, Tithonius, Juventae, Auri, Protei, and an unnamed one designated by Antoniadi in 1909

as (b). The canals were Agathodaemon, Daemon, Nectar, Caicus (L), Baetis, Garrhuenus (L), Erannoboas (L), Dargamanes (L), Glaucus, Eosphorus, Jamuna, Nilokeras, and a previously unnamed canal leading to Ambrosia from the Protei regio.

This is the first appearance this year of the smaller lakes and of the canals in the dark regions of the planet. It may be of interest to recall that the first announcement both of the finding of these lakes in number comparable to the canals, and of the first finding of the canals in the dark regions of the planet, was made in "Astronomy and Astrophysics" the precursor of POPULAR ASTRONOMY" in the year 1892. The interest of the latter discovery lay in the fact that it showed that these regions were not water as was at that time generally assumed.

Jan. 4. **6** Protonilus, Callirrhoe (L), Aurum (L). The first of these apparently ended in the desert, there being neither lake nor canal at its termination. This was formerly supposed to be an unknown condition, but it has occasionally been noted of late years. The appearance was very like the Margaritifer sinus.

Jan. 5. **1** Tithonius, Solis, and Ambrosia lacus, Agathodaemon, Nectar.

Jan. 6. **6** Protonilus.

Jan. 10. **6** Aenarium lacus (L). This lake was situated on Protonilus, with the canal stretching and ending beyond it. Orontes, Arsanias (L), Apis (L).

Jan. 11. **6** Aenarium and Sirbonis lacus. Protonilus, Orontes, Arsanias, Apis. None of these canals were over 100 miles in width and were quite a contrast in this respect to many of those previously recorded.

The three as above noted were extremely faint.

Jan. 12. **6** Aenarium lacus, Protonilus, Orontes, Arsanias, Apis.

Jan. 15. **5** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, all very conspicuous.

The greatest number of lakes and canals visible on any single sketch was on Dec. 31, where seven lakes and thirteen canals were recorded.

The following Table of data is arranged precisely like the one which appeared last month, the only headings needing explanation are: ⊙ which is the longitude of the sun as seen from Mars, and measured from the Vernal equinox of the planet; M.D. which is the equivalent date of our terrestrial year or we might say simply the Martian date; and Sun which is the declination of the sun as observed from Mars.

TABLE OF DATA.

No.	1913-4.	⊙	M.D.	Long.	Lat.	Sun	Diam.	Seeing
		°		°	°	°	″	
36	Dec. 17	8.1	Mar. 28	185	+8	+3	14.5	10
37	18	8.6	"	177	"	"	14.6	8
38	19	9.0	29	162	"	+4	14.7	9
39	22	10.5	30	168	+7	"	14.8	9
40	23	11.0	31	172	"	"	14.9	10
41	25	11.9	Apr. 1	125	+6	+5	"	12
42	"	"	"	155	"	+6	15.0	8
43	30	14.3	3	78	"	"	"	12
44	"	"	"	101	"	"	"	12
45	31	14.7	"	64	+5	"	"	10
46	"	"	"	95	"	"	"	8
47	Jan. 4	16.6	5	5	"	+7	"	10
48	5	17.1	6	41	+4	"	"	12
49	6	17.6	"	351	"	"	"	8
50	10	19.4	8	342	"	+8	14.8	12
51	"	"	"	358	"	"	"	—
52	12	20.4	9	338	+3	"	14.7	8
53	15	21.8	11	281	"	"	14.4	6
54	"	"	"	301	"	"	"	5

Besides describing the writer's own observations of Mars, he proposes to make very brief notes of any publications relating to the planet that may come to his attention. As he is located far from any library, he would be glad to receive copies of any such publications as may be generally distributed.

The Astr. Nach. 4706 is devoted to a micrometric survey of the planet by Professor Lau. Comparing his results with those of Schiaparelli, he finds that the earlier determined longitudes require a positive correction of about 5°. In this he states he is corroborated by the results of Wislicenus, 1890, Astr. Nach. 3034, and Lowell 1894 M. N. **56**, 405. As an instance of a striking deviation, he finds that Schiaparelli makes the longitude of Aryn 4°.4 too great, and that of Margaritifer 2°.4 too small, thus giving a distance between them of 21°.3, while he makes the distance 28°.1. That so large an error could have been made by so careful an observer as Schiaparelli seems almost inconceivable.

It occurred to the writer therefore that it might be of interest to see what bearing his own drawings, made this year, would have on the question. While Aryn is not yet visible, the two bays between which it lies, as well as Margaritifer are well placed for measurement upon five of his drawings. The results are as follows: Nov. 30 28°.3, Dec. 2 26°.7, Dec. 3 26°.7, Jan. 6 20°.8, Jan. 10 19°.5. The result can hardly be called conclusive, but it looks as if both observers might be right. Measures of the writer's drawings made at Arequipa in 1892 agree with Schiaparelli. In latitude, Lau finds that Schiaparelli's results are all too far to the north, the difference in one case amounting to 6°. Here it seems very probable that merely a seasonal change is indicated.

The next number of the Astr.Nach., 4707, contains two telegrams from Lowell. One of January 9 states that the transit of the Martian zero meridian was twelve minutes ahead of the Ephemeris. This is corroborated by the writer's observations, which will appear elsewhere. The other of January 13 states that the Martian southern cap is beginning in stippled patches of hoarfrost between longitudes 30° and 60°. Our last observation of this region was made on January 5, when the polar region was recorded as yellow. A telegram of January 12 from Jarry-Desloges states that the "régions australes présentaient troubles importants", that Hellas is nearly invisible, and that the Moeris Nepenthes Nuba system is very large and dark. According to our observations Hellas does seem to be rather under a cloud at present, and this may be one of the "troubles" to which he refers. We wish he had been more explicit about the others. The Moeris Nepenthes region we found very dark in December, and it received a further sudden accession of darkness, if such a phrase is allowable, between January 15 and 17. Observations and drawings by others of this interesting region will be welcomed.

JANUARY NIGHTS.

Now beams the fairest tract of heaven's expanse,
As winter deepens skies more radiant glow,
The rainy Hyads lead the stellar dance
And mock the boreal rage of Aquilo.

Full overhead Capella's yellow star
Gleams near the Milky Way's elusive blurs,
Castor and Pollux too, and, southward far,
Shine Rigel white and ruddy Betelgeuse.

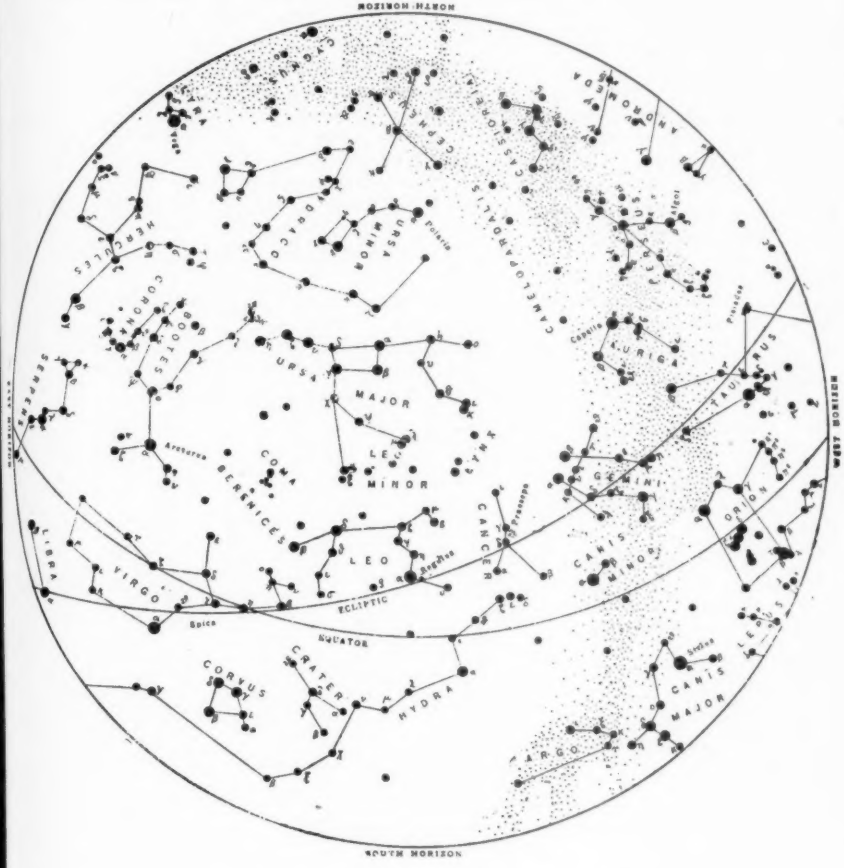
Not distant sparkles Procyon's topaz light,
Gleams red Aldebaran and the Pleiads seven,
And, ranking as the monarch of the night,
Glows blue-white Sirius, Kohinoor of heaven!

WARREN H. CUDWORTH.

Norwood, Massachusetts.

PLANET NOTES FOR APRIL, 1914.

The sun will move a little more than ten degrees northward during this month and will be nearly 15° north of the equator at the end. It will move eastward from the constellation Pisces into Aries.



THE CONSTELLATIONS AT 9:00 P. M. APRIL 1, 1914.

The phases of the moon for this month are as follows:

First Quarter	Apr. 3	at	2 P.M.	C. S. T.
Full Moon	10	"	7 A.M.	"
Last Quarter	17	"	2 A.M.	"
New Moon	25	"	5 A.M.	"

Mercury may be visible in the morning sky just before sunrise about April 6 when it reaches a point of greatest western elongation. It will at this time be several degrees south of the sun, which will be unfavorable to its rising very long before the sun. At this time about one half of the illuminated disk will be visible and it will be somewhat brighter than a star of the first magnitude.

Venus will move eastward faster than the sun. It will also be moving northward rapidly, and by the end of the month will be quite a distance from the western horizon at sunset. It will be several times as bright as the brightest star in the sky, because nearly the entire illuminated disk will be turned toward us.

Mars will be in quadrature, 90 degrees east of the sun on April 10. It will therefore be in very good position for observation throughout the month. It will be moving eastward at the rate of about a half a degree each day and will be receding from the earth. About the middle of the month it will be 125,000,000 miles away. It will be about as bright as a star of the first magnitude.

Jupiter will be moving eastward slowly and will rise a little earlier each morning. It will be visible in the morning sky and will be the conspicuous morning star at this season.

Saturn will still be visible throughout the month but at the end it will be too low at sunset for favorable observations.

Uranus will be visible in the southeast after midnight. It will have a slow retrograde motion during the month.

Neptune will be in quadrature, 90 degrees east of the sun, on April 15. At this season it will be rather near to the planet Mars. It will therefore be favorably situated. It will still be in the eastern part of the constellation Gemini.

Occultations Visible at Washington.

Date 1914	Star's Name	Magnitude	IMMERSION. Washington M.T. h	m	Angle from N. °	EMERSION. Washington M.T. h	m	Angle from N. °	Duration h	m
Apr. 1	354 B Tauri	6.4	7	45	127	8	48	243	1	3
3	134 B. Gemin.	6.5	7	43	59	8	33	342	0	50
7	*c* Leonis	5.1	8	14	127	9	28	311	1	14
9	ψ Virginis	5.0	11	59	134	13	11	302	1	12
11	17 G Librae	6.4	9	8	105	10	7	316	0	59
11	18 G Librae	6.1	9	38	107	10	40	315	1	2
12	*b* Scorpii	4.7	10	20	86	11	16	324	0	56
12	4 Scorpii	5.7	12	36	96	13	48	310	1	12
18	δ Capricorni	3.0	15	25	19	16	12	296	0	48
19	58 Aquarii	6.4	15	15	14	15	56	297	0	41
28	38 B Aurigae	6.5	6	32	78	7	38	289	1	6

Phenomena of Jupiter's Satellites.

[Visible at Washington.]

CENTRAL STANDARD TIME

1914	h	m		1914	h	m	
Apr. 7	15	16	IV Oc. Re.	Apr. 22	13	34	II Ec. Dis.
7	15	35	I Ec. Dis.	23	13	49	I Ec. Dis.
8	15	9	I Sh. Eg.	24	13	33	II Tr. Eg.
15	14	42	I Sh. In.	24	14	43	I Tr. Eg.
15	15	57	I Tr. In.	29	14	51	III Ec. Re.
16	15	28	I Oc. Re.				

Note:—In., denotes ingress; Eg., egress; Dis., disappearance; Re., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

VARIABLE STARS.

Approximate Magnitudes of Variable Stars of Long Period on Feb. 1, 1914.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name:	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900 h m	Decl. 1900 ° ′	Magn
X Androm.	0 10.8	+46 27	14.2	S Lyncis	6 35.9	+58 0	14.0
T Androm.	17.2	+26 26	<10.0	X Gemin.	40.7	+30 23	11.0
T Cassiop.	17.8	+55 14	8.6	Y Monoc.	51.3	+11 22	11.8
R Androm.	18.8	+38 1	9.3 *i*	X Monoc.	52.4	— 8 56	7.8
Y Cephei	31.3	+79 48	10.0 *i*	R Lyncis	53.0	+55 28	8.2 *i*
U Cassiop.	40.8	+47 43	<11.0	V Can. Min.	7 1.5	+ 9 2	12.2*d*
RW Androm.	41.9	+32 8	<12.0	R Gemin.	1.3	+22 52	11.0*d*
V Androm	44.6	+35 6	12.7*d*	R Can. Min.	3.2	+10 11	9.7
RR Androm.	45.9	+33 50	9.9*d*	RR Monoc.	12.4	+ 1 17	10.7 *i*
RV Cassiop.	47.1	+46 53	11.0*d*	S Can. Min.	27.3	+ 8 32	7.9 *i*
W Cassiop.	49.0	+58 1	10.0 *i*	U Can.Min.	35.9	+ 8 37	10.7*d*
U Androm.	1 9.8	+40 11	9.8 *i*	R Cancri	8 11.0	+12 2	10.5 *i*
– Androm.	10.4	+41 12	14.0	V Cancri	16.0	+17 36	9.2*d*
S Piscium	12.4	+ 8 24	13.0*d*	S Hydrae	48.4	+ 3 27	11.0
S Cassiop.	12.3	+72 5	12.7*d*	T Cancri	51.0	+20 14	7.9
RZ Persei	23.6	+50 20	14.0	W Cancri	9 4.0	+25 39	12.2
RU Androm.	32.8	+38 10	13.0	Y Draconis	31.1	+78 18	14.2
Y Androm.	33.7	+38 50	10.6*d*	R Leonis	42.2	+11 54	6.0
X Cassiop.	49.8	+58 46	10.0	U Hydrae	10 32.6	—12 52	4.8
U Persei	53.0	+54 20	8.2	R Urs. Maj.	37.6	+69 18	13.1
R Arietis	2 10.4	+24 35	9.8	R Virginis	12 33.4	+ 7 32	7.0
W Androm.	11.2	+43 50	7.0	T Urs .Maj.	31.8	+60 2	12.6
Z Cephei	12.8	+81 13	13.8	RS Urs. Maj.	34.4	+59 2	12.8*d*
o Ceti	14.3	— 3 26	5.4 *i*	S Urs. Maj.	39.6	+61 38	8.5 *i*
S Persei	15.7	+58 8	10.0	S Virginis	13 27.8	— 6 41	7.8*d*
RR Persei	21.7	+50 49	14.2	T Urs. Min.	32.6	+73 56	11.4*d*
U Ceti	28.9	—13 35	10.3*d*	R Can. Ven.	44.6	+40 2	8.5 *i*
RR Cephei	29.4	+80 42	10.1*d*	U Urs. Min.	14 15.1	+67 15	8.6
R Trianguli	31.0	+33 50	7.5*d*	S Bootir	19.5	+54 16	10.1 *i*
W Persei	43.2	+56 34	9.8	RS Virginis	22.3	+ 5 8	12.6
U Arietis	3 5.5	+14 25	9.4 *i*	V Bootis	25.7	+39 18	10.8
X Ceti	14.3	— 1 26	9.7*d*	R Camelop.	25.1	+84 17	8.8
Y Persei	20.9	+43 50	9.7	R Bootis	32.8	+27 10	7.0
R Persei	23.7	+35 20	8.4	Y Librae	15 6.4	— 5 38	11.8
U Camelop	33.2	+62 19	7.4	RU Librae	27.7	—14 59	13.6
V Eridani	59.8	—16 0	9.4	S Urs. Min.	33.4	+78 58	11.6
W Tauri	4 22.2	+15 49	9.1*d*	X Herculis	59.6	+47 31	6.4
– Tauri	32.8	+ 8 9	9.0	W Cor. Bor.	16 11.8	+38 3	10.2*d*
X Camelop.	32.6	+74 56	12.8*d*	R Draconis	32.4	+66 58	11.4 *i*
R Orionis	53.6	+ 7 59	11.5	T Draconis	17 54.8	+58 14	11.0
R Leporis	55.0	—14 7	12.8*d*	V Draconis	56.3	+54 53	14.0
R Aurigae	5 9.2	+53 28	8.2	T Herculis	18 5.3	+31 0	<11.0
S Aurigae	20.5	+34 4	9.2	W Draconis	5.4	+65 56	12.0*d*
W Aurigae	20.1	+36 49	9.6*i*	X Draconis	6.8	+66 8	13.2 *i*
S Orionis	24.1	— 4 46	12.6	W Lyrae	11.5	+36 38	8.6
T Orionis	30.9	— 5 32	10.0	SV Draconis	31.2	+49 18	10.0*d*
SU Tauri	43.2	+19 2	14.0	RY Lyrae	41.2	+34 34	13.4
RU Tauri	46.9	+15 57	13.3	Z Lyrae	56.0	+34 49	9.4
U Orionis	49.9	+20 10	12.0	V Lyrae	19 5.2	+29 30	12.2 *i*
V Camelop.	49.4	+74 30	<13.0	S Lyrae	9.1	+25 50	11.0*d*
Z Aurigae	53.6	+53 18	10.4	U Draconis	9.9	+67 7	12.7 *i*
V Monoc.	6 17.7	— 2 9	8.0 *i*	U Lyrae	16.6	+37 42	8.3
U Lyncis	31.8	+59 57	13.8	R Cygni	34.1	+49 58	9.8 *i*

Approximate Magnitudes of Variable Stars of Long Period on Feb. 1, 1914.—Continued.

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900. h m	Decl. 1900. ° ′	Magn
TT Cygni	19 37.1	+32 23	8.1	W Cygni	21 32.2	+44 56	6.4
RT Cygni	40.8	+48 32	9.6 *i*	S Cephei	36.5	+78 10	11.4*d*
TU Cygni	43.3	+48 49	9.0	RV Cygni	39.1	+37 34	6.6
χ Cygni	46.7	+32 40	8.4*d*	Y Pegasi	22 6.8	+13 52	<13.0
SV Cygni	20 6.5	+47 35	9.2	RS Pegasi	7.4	+14 4	12.4
RS Cygni	9.8	+38 28	7.8	S Lacertae	24.6	+39 48	12.1
SX Cygni	11.6	+30 46	11.0	R Pegasi	23 1.6	+10 0	10.0*d*
ST Cygni	29.9	+54 38	10.8*d*	V Cassiop.	7.4	+59 8	10.3*d*
RZ Cygni	48.5	+46 59	11.6	ST Androm.	33.8	+35 13	10.8
TW Cygni	21 1.8	+29 0	13.6	X Cassiop.	39.7	+56 2	11.1*d*
X Cephei	3.6	+82 40	14.2	R Cassiop.	53.3	+50 50	11.6*d*
R Equulei	8.4	+12 23	<13.0	Y Cassiop.	58.2	+55 7	10.3*d*
T Cephei	8.2	+68 5	8.7*d*	SV Androm.	59.2	+39 33	12.8*d*

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign < that the variable is fainter than the appended magnitude.

The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:—H. C. Bancroft, Jr., T. C. H. Bouton, A. P. C. Craig, Edward Gray S. H. Huntington, S. C. Hunter, M. W. Jacobs, Jr., J. B. Lacchini, F. C. Leonard, C. Y. McAteer, W. T. Olcott, P. G. O'Reilly, E. Padova, E. W. Putnam, H. M. Swartz, D. Todd, H. W. Vrooman I. E. Woods. M Yamasaki, and A. S. Young.

Maxima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes and May E. Abbott at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of maxima in 1914 April d h d h d h d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7	20 6
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	8 12; 16 15; 24 18
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 15; 10 9; 18 3; 25 21
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	6 17; 21 12
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	3 7; 11 5; 19 4; 27 2
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	7 7; 15 2; 22 21; 30 16
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	1 18; 9 1; 23 15; 30 22
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	2 0; 18 0
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	7 19; 16 9; 24 23
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	11 12; 22 15
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	10 21; 22 12
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	4 10; 12 1; 19 17; 27 9
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	2 18; 12 21; 23 0
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	5 23; 13 16; 21 9; 29 3
RZ Gemin.	5 56.6	+22 12	9.1—10.0	5 12.7	2 20; 8 9; 19 10; 30 12
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	3 19; 11 9; 18 23; 26 12
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	26 10
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	1 8; 8 13; 22 23; 30 4
W Gemin.	6 29.2	+15 24	6.7— 7.5	7 22.0	1 12; 9 10; 17 8; 25 6
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2 19; 12 23; 23 3
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	2 14; 24 21

Maxima of Variable Stars of Short Period.—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1914. April
	h m	° ′		d h	d h d h d h d h d h
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	1 1; 8 23; 16 22; 24 21
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	5 21; 12 14; 19 6; 25 23
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	4 23; 14 6; 23 12
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	8 18; 17 12; 26 6
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 0.0	21 0
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	3 3; 9 22; 23 12; 30 7
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	2 11; 9 1; 22 6; 28 21
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	1 15; 11 7; 20 23; 30 15
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	1 0; 8 23; 16 23; 24 22
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	2 14; 9 7; 22 19; 29 12
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	5 24; 11 19; 23 11; 29 7
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	5 0; 9 17; 23 18; 28 11
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	15 10
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	1 5; 9 10; 17 14; 25 19
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	4 11; 11 12; 18 12; 25 13
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	5 16; 13 21; 22 2; 30 7
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	5 7; 10 10; 21 18; 27 6
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	5 1; 12 14; 20 4; 27 17
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	7 11; 14 21; 22 7; 29 16
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	4 16; 11 11; 18 6; 25 0
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	4 8; 10 15; 23 7; 29 15
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	4 13; 14 7; 24 1
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	1 9; 10 5; 19 2; 27 23
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	4 10; 10 11; 22 14; 28 16
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	6 17; 13 17; 20 18; 27 18
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	10 14; 27 17
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	2 21; 10 12; 18 2; 25 16
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	3 14; 9 9; 20 22; 26 16
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	6 17; 13 11; 20 5; 26 22
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	5 10; 15 19; 26 3
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	1 4; 7 5; 19 6; 25 7
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	6 11; 12 15; 18 18; 24 21
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	4 3; 10 1; 21 23; 27 21
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	6 19; 15 21; 24 23
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	5 12; 12 13; 19 14; 26 14
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	1 10; 8 10; 22 10; 29 10
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	2 5; 10 4; 18 4; 26 3
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	2 1; 9 18; 17 10; 25 3
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	8 1; 15 5; 22 9; 29 13
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	2 7; 10 16; 19 2; 27 11
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	2 12; 8 19; 21 11; 27 18
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	11 22; 28 8
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	5 5; 14 2; 22 23; 27 9
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	3 20; 10 13; 17 7; 30 18
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	4 16; 11 9; 18 2; 24 19
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	15 11; 30 5
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	6 20; 14 17; 22 13; 30 10
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	7 15; 14 13; 21 10; 28 7
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	5 1; 14 19; 24 12; 29 9
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	5 7; 13 23; 22 14
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	6 1; 11 10; 22 4; 27 12
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	4 2; 15 0; 25 21
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	1 15; 8 1; 20 22; 27 8
V Lacertae	22 44.5	+55 48	8.2— 8.9	4 23.6	1 10; 11 9; 21 8; 26 8
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	1 13; 12 11; 23 8; 28 18
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	6 2; 12 9; 18 16; 24 23
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	9 10; 21 13
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	5 8; 15 8; 25 7; 30 7

Minima of Variable Stars of Short Period.

[Calculated by May E. Abbott, at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1914 April
	h m	° ′		d h	d h d h d h d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	16 24
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	5 6; 12 22; 20 14; 28 6
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	5 12; 12 22; 20 9; 27 19
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	4 14; 12 1; 19 13; 27 0
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	4 15; 10 17; 22 23; 29 2
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	3 10; 10 14; 17 17; 24 21
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	4 18; 11 15; 18 11; 25 8
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	3 10; 10 14; 17 18; 24 22
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	6 6; 15 1; 23 20
ST Persei	2 53.7	+38 47	8.5—10.5	2 15.6	4 14; 12 12; 20 11; 28 10
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	2 15
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	5 15; 11 9; 22 20; 28 14
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	4 7; 11 2; 17 22; 24 17
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	2 24; 10 22; 18 19; 26 17
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	1 20; 10 3; 18 10; 26 18
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	1 3; 9 0; 16 22; 24 19
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	6 7; 19 12
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	6 1; 15 12; 24 23
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	10 1; 22 12
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	2 9; 9 1; 22 9; 29 1
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	4 21; 10 8; 21 6; 26 17
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	3 2; 9 3; 21 4; 27 5
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	3 4; 11 20; 20 12; 29 4
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	9 1; 19 11; 29 21
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	2 5; 10 5; 18 5; 26 6
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	2 10; 8 4; 19 15; 25 8
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	3 5; 8 19; 20 0; 25 15
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	2 23; 11 4; 19 9; 27 13
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	4 4; 11 19; 19 10; 27 1
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	5 13; 17 18; 29 23
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	2 1; 9 5; 23 13; 30 17
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	6 1; 15 3; 24 5
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	5 20; 15 3; 24 11
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	10 9; 20 7; 30 5
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	3 10; 11 20; 20 5; 28 15
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	7 6; 13 17; 20 3; 26 13
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	5 6; 12 12; 19 19; 27 1
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	2 21; 11 0; 19 3; 27 6
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	2 21; 12 9; 21 21
RX Hydrae	9 0.8	− 7 52	9.1—10.5	2 6.8	2 15; 11 18; 20 21; 30 0
S Antliae	27.9	−28 11	6.3— 6.8	0 07.8	3 17; 10 5; 23 4; 29 16
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	1 22; 7 20; 19 17; 25 15
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	6 16; 15 3; 23 13
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	9 6; 18 12; 27 19
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	4 7; 10 21; 24 2; 30 16
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	3 14; 12 10; 21 5; 30 0
RW Urs. Maj.	35.4	−52 34	10.3—11.4	7 07.9	2 21; 10 5; 17 13; 24 21
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	4 22; 11 17; 18 12; 25 7
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	8 10; 15 22; 23 10; 30 22
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	6 24; 14 10; 21 21; 29 7
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	4 2; 11 1; 18 1; 25 1
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	4 19; 11 17; 18 15; 25 12
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	5 8; 13 18; 22 4; 30 14
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	5 16; 13 7; 20 23; 28 15

Minima of Variable Stars of Short Period.—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean time of minima in 1914 April
	h m	° ′		d h	d h d h d h d h
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	2 16; 10 0; 17 9; 24 17
SX Ophiuchi	16 12.6	− 6 25	10.5—11.2	2 01.5	4 10; 12 16; 20 22; 29 14
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	6 5; 15 2; 23 22
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	5 15; 16 17; 26 10
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	7 6; 14 1; 20 21; 27 16
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	2 17; 11 2; 19 11; 27 21
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	3 5; 9 8; 21 16; 27 19
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	6 1; 13 6; 20 11; 27 16
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	2 14; 9 23; 17 8; 24 17
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	6 14; 14 18; 22 22
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	5 7; 12 20; 20 9; 27 22
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 12; 11 6; 18 24; 26 18
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	6 9; 14 9; 22 9; 30 8
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	5 17; 14 5; 22 18
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	5 7; 14 15; 23 23
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	11 4; 21 12
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	3 12; 10 18; 18 0; 25 6
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	1 23; 8 21; 22 17; 29 15
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	6 13; 21 16
RZ Draconis	21.8	+ 58 50	9.5—10.2	0 13.2	4 16; 12 23; 21 5; 29 11
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	8 7; 17 5; 26 2
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	1 16; 9 24; 18 7; 26 14
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 15; 14 3; 22 15
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	4 11; 11 2; 17 17; 24 9
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	1 10; 14 8; 27 6
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	2 23; 12 12; 22 1
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	7 11; 15 1; 22 15; 30 5
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	5 22; 13 3; 20 8; 27 13
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	7 6; 16 5; 25 4
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	7 10; 14 5; 20 23; 27 17
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	1 17; 9 1; 16 10; 23 19
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	2 24; 13 12; 23 23; 29 5
UZ Draconis	26.1	+ 68 44	9.0— 9.8	1 15.1	5 7; 11 19; 18 8; 24 20
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	1 15; 7 16; 19 16; 25 16
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	3 1; 9 16; 22 22; 29 14
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	5 20; 14 23; 24 3
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	3 14; 11 24; 20 10; 28 21
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	4 3; 10 22; 17 17; 24 11
UW Cygni	19.6	+42 55	10.5—13	3 10.8	2 0; 8 22; 22 17; 29 15
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0	5 5
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	8 1; 17 15; 27 6
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	2 12; 11 16; 20 21; 30 2
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	4 13; 12 1; 19 13; 27 0
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	2 23; 8 19; 20 11; 26 8
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	3 16; 13 19; 23 21
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	1 16; 9 1; 16 11; 23 20
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	7 13; 17 6; 26 22
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	5 6; 13 3; 20 24; 28 21
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	28 12
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	2 23; 13 3; 23 6
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	5 10; 10 14; 20 23; 26 3
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	3 13; 14 10; 25 7; 30 18
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	3 17; 12 1; 20 8; 28 15
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	4 1; 11 14; 19 3; 26 15
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	5 15; 13 20; 22 2; 30 8

COMET AND ASTEROID NOTES.

Comet 1913 *f* (Delavan).—The comet is slowly brightening and will doubtless become conspicuous when it nears perihelion next October. The latest elements do not differ very greatly from those which we published last month, so that the diagrams then given are sufficiently accurate to represent the relative motions of the earth and comet.

The following elements are at hand, those obtained by Einarsson and Nicholson at Berkeley, Cal., being undoubtedly the best:

ELEMENTS OF COMET 1913 *f*.

Computers	Wilson	Van Biesbroeck	Einarsson and Nicholson
Dates of observations	Dec. 17, 29, Jan. 14	Dec. 19, 29, Jan. 14	Dec. 17, 18, 19, 27, 29 Jan 31
T	1914 Oct. 23.9254 Gr.M.T.	Oct. 26.458 Berlin	Oct. 26.6425 Gr. M.T.
ω	97° 44′ 49″.5	97° 26′.8	97° 26′ 39″.5
Ω	59 29 24.0	59 10.5	59 09 28.5
i	67 25 03.0	68 05.7	68 07 42.1
log q	0.036810	0.04353	0.043810

From the elements by Wilson, Professor C. H. Gingrich has computed the following ephemeris for March:

EPHEMERIS OF COMET 1913 *f* (DELAVAN).

Gr. Midn.	α	δ	log r	log Δ	Brightness
	h m s	° ′ ″			
March 3.5	2 43 23.5	+4 09 14	0.5353	0.5850	1.21
4.5	43 46.5	4 20 17			
5.5	44 10.3	4 31 22			
6.5	44 34.9	4 42 27			
7.5	45 00.3	4 53 34	0.5288	0.5863	1.24
8.5	45 26.5	5 04 42			
9.5	45 53.4	5 15 52			
10.5	46 21.2	5 27 02			
11.5	46 49.8	5 38 14	0.5231	0.5874	1.26
12.5	47 19.1	5 49 26			
13.5	47 49.2	6 00 40			
14.5	48 20.0	6 11 55			
15.5	48 51.7	6 23 11	0.5174	0.5882	1.29
16.5	49 24.1	6 34 28			
17.5	49 57.3	6 45 46			
18.5	50 31.2	6 57 06			
19.5	51 05.9	7 08 26	0.5116	0.5888	1.32
20.5	51 41.3	7 19 48			
21.5	52 17.5	7 31 11			
22.5	52 54.3	7 42 35			
23.5	53 31.9	7 54 00	0.5056	0.5890	1.36
24.5	54 10.2	8 05 26			
25.5	54 49.2	8 16 53			
26.5	55 28.9	8 28 21			
27.5	56 09.3	8 39 50	0.4996	0.5889	1.40
28.5	56 50.4	8 51 20			
29.5	57 32.1	9 02 52			
30.5	58 14.5	9 14 24			
31.5	2 58 57.7	+9 25 58	0.4934	0.5885	1.44

Brightness Dec. 17, 1913 = 1.00.

The correction required to reduce this ephemeris to one calculated from the elements by Einarsson and Nicholson (*L. O. Bulletin* 250) is, for March 20.5:

$$\Delta\alpha = -14^s.5 \quad \Delta\delta = -1' 42''.$$

The following approximate positions and brightness of the comet have been computed by Miss Julia I. Mackay and Mr. C. D. Shane of the Berkeley Astronomical Department (see *L. O. Bulletin* 250). These indicate that the comet will be very bright in September and October, and may become visible to the naked eye. During the greater part of September it will be a circumpolar object as seen from our northern latitude, being visible all night.

APPROXIMATE POSITIONS 1914-15.

		α	δ	log Δ	Br.
		h m	°		
1914	June 18	4 28	+26.2	0.50	4
	Sept. 16	10 08	+50.0	0.22	48
	Oct. 26	14 12	+26.7	0.23	62
	Dec. 5	15 58	+ 1.0	0.32	30
1915	Jan. 14	17 03	−15.2	0.37	14

Encke's Comet and Mercury.—Mr. F. E. Seagrave calls attention to the fact that Encke's comet will make a near approach to Mercury next winter. On December 17, 1914, at Greenwich noon the heliocentric coördinates of the comet and Mercury will be as follows:

	Encke's comet	Mercury
	° ′ ″	° ′ ″
Longitude	224 06 18	230 38 15
Latitude	−11 48 39	−0 24 25
Log. radius vector	9.66480	9.65824

Distance between the two, $\Delta = 0.1078$.

The comet is due at perihelion Dec. 5.89.

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, Jan.-Feb., 1914.—Notwithstanding the inclement weather that has prevailed over the entire country during the past month, we have succeeded in observing a larger number of variables than for any month since our organization. This clearly indicates that our observers are alive to the efforts being made to extend the work in accordance with Professor Pickering's wishes.

It is gratifying to announce that Miss Mabel A. Dyer, and Miss Grace Buffum, of the staff of Dudley Observatory, Albany, N. Y., will coöperate with us in the observation of variables.

Mr. Bancroft again leads the class with a total of 213 observations of ninety-five variables, a fine record considering the few clear nights during the month. Mr. Bancroft also deserves great credit for the many beautifully executed tracings of the charts that he has made. He recently sent the secretary over a thousand blue prints, comprising five complete sets of two hundred variables, so that we are now in a position to distribute material as it is needed, and to furnish on application charts of the neglected variables.

Variable Star Observations Jan.-Feb., 1914.

001726 T Androm.

Mo.	Day	Est.	Obs.
2	2	11.5	Y

001755 T Cassiop.

Mo.	Day	Est.	Obs.
1	5	8.6	Bu
	16	8.8	Bu
	27	8.6	M
	27	7.9	Ba
	28	8.6	S
	31	8.6	G

001838 R Androm.

Mo.	Day	Est.	Obs.
1	12	10.8	V
	22	9.3	Hu
	28	9.4	O
2	1	9.3	P

003179 Y Cephei

Mo.	Day	Est.	Obs.
1	8	10. 7	Hu
	22	11.0	Ba
	27	10.0	Ba
2	1	9.7	Hu

004047 U Cassiop.

Mo.	Day	Est.	Obs.
1	24	11.7	E
2	2	11.9	Y

004435 V Androm.

Mo.	Day	Est.	Obs.
1	1	11.6	Ba
	22	12.6	Hu

004533 RR Androm.

Mo.	Day	Est.	Obs.
1	1	9.2	Ba
	22	9.7	Ba
	22	9.2	Hu
	25	9.6	O
	26	9.0	Bu
	28	9.8	Ba
2	1	8.7	Hu

004746 RV Cassiop.

Mo.	Day	Est.	Obs.
12	27	9.3	L
1	1	10.7	Ba
	22	10.7	Ba
	24	11.0	L
	28	10.9	Ba

004958 W Cassiop.

Mo.	Day	Est.	Obs.
1	1	10.0	Ba
	5	9.8	Ba
	22	10.2	Ba
	27	10.1	Ba

010940 U Androm.

Mo.	Day	Est.	Obs.
1	1	10.8	Ba
	22	10.3	Ba
	28	10.1	Ba

011208 S Piscium

Mo.	Day	Est.	Obs.
1	1	12.1	Ba
	26	12.4	Ba
	28	12.8	Y

011272 S Cassiop.

Mo.	Day	Est.	Obs.
1	23	12.6	Ba

013238 RU Androm.

Mo.	Day	Est.	Obs.
2	1	12.6	J

013338 Y Androm.

Mo.	Day	Est.	Obs.
1	1	8.9	Ba
	5	9.0	Bu
	16	9.4	Bu
	22	9.7	Ba
	28	10.1	Ba
2	1	10.6	J

014958 X Cassiop.

Mo.	Day	Est.	Obs.
1	5	9.8	Ba
	26	10.1	Ba
	26	10.4	Bu
2	2	9.6	Y

015254 U Persei

Mo.	Day	Est.	Obs.
1	5	9.4	Ba
	16	9.0	Bu
	26	8.5	Ba
	28	8.3	Y
2	1	8.4	P

021024 R Arietis

Mo.	Day	Est.	Obs.
1	22	9.7	O
	28	9.8	S

021403 *o* Ceti

Mo.	Day	Est.	Obs.
12	27	8.5	L
1	3	8.4	G
	5	8.4	Bu
	5	7.7	Ba
	8	7.3	Ya
	9	7.1	Ya
	10	7.2	Ya
	10	7.8	G
	15	6.8	L
	16	8.0	Bu
	18	7.3	G
	19	6.6	Ya
	22	5.9	Hu

o Ceti

Mo.	Day	Est.	Obs.
22	6.2	O	
25	5.5	L	
25	5.4	L	
26	5.5	Ba	
27	6.1	Ya	
27	5.9	G	
1	5.0	Hu	
2	4.5	Le	

021258 T Persei

Mo.	Day	Est.	Obs.
1	5	8.8	Bu
	27	8.6	Ya
	28	8.7	Ya
	30	8.9	Ya

021558 S Persei

Mo.	Day	Est.	Obs.
1	5	10.2	Bu
	5	10.2	Ba
	26	10.5	Ba
	27	10.7	Ya
	28	10.9	Ya
	30	10.8	Ya
	31	10.0	C

022813 U Ceti

Mo.	Day	Est.	Obs.
1	1	8.7	Ba
	5	8.7	Bu
	3	7.8	G
	8	8.0	G
	16	9.2	Bu
	18	9.0	G
	26	10.2	Ba

023133 R Trianguli

Mo.	Day	Est.	Obs.
1	1	7.2	Ba
	22	7.7	O
	26	7.0	Bu
	26	7.6	Ba
	27	7.3	G
	28	7.5	B
	31	7.5	G
2	1	7.6	Le

024356 W Persei

Mo.	Day	Est.	Obs.
12	27	9.5	L
	5	9.4	Bu
	5	9.1	Ba
	12	10.1	V
	16	9.4	Bu
	22	9.5	Hu
	25	9.7	L
	26	9.0	Ba
	27	9.5	M
	30	10.0	
2	1	9.3	L

030514 U Arietis

Mo.	Day	Est.	Obs.
1	1	12.6	Ba
	22	10.3	Fu
	26	10.0	Ba
	31	9.5	Ba

032043 Y Persei

Mo.	Day	Est.	Obs.
1	1	10.3	Ba
	4	10.5	G
	5	10.7	Bu
	5	10.2	Ba
	16	10.8	Bu
	22	9.8	Hu
	26	9.8	Ba
	27	10.4	M
	27	9.7	Ba
	28	9.8	Ba
	30	10.4	G
	31	9.7	Ba
2	1	10.0	Hu
	1	10.0	P

032335 R Persei

Mo.	Day	Est.	Obs.
1	1	8.6	Ba
	5	8.5	Ba
	8	8.9	Ya
	9	8.9	Ya
	10	8.8	Ya
	19	8.9	Ya
	25	8.2	Hu
	26	8.4	Ba
	28	9.0	S
	28	9.0	Ya
	30	9.0	Ya
	31	8.4	Ba
2	1	8.7	Hu

033362 U Camelop.

Mo.	Day	Est.	Obs.
1	5	7.5	Ba
	26	7.4	Ba
2	1	7.2	Le

035915 V Eridani

Mo.	Day	Est.	Obs.
1	5	9.1	Ba
	8	9.5	G
	26	9.5	Ba

042215 W Tauri

Mo.	Day	Est.	Obs.
1	1	8.7	Ba
	5	8.8	Bu
	3	8.3	G
	10	8.7	B
	14	8.8	Ba
	14	8.8	B
	17	8.5	G
	18	9.4	O
	22	8.9	B

W Tauri

Mo.	Day	Est.	Obs.
1	22	9.0	Ba
	25	9.7	O
	26	9.1	Ba
	27	9.0	M
	28	9.9	Gu
	28	8.9	B
	30	9.0	G
	31	9.1	Ba
2	1	10.0	O
	1	8.8	M
	1	9.2	Hu

043209 R Tauri

Mo.	Day	Est.	Obs.
1	22	13.4	Fu

042209 S Tauri

Mo.	Day	Est.	Obs.
2	1	10.8	M

043208 RX Tauri

Mo.	Day	Est.	Obs.
1	14	10.4	B
	22	9.8	B
	25	9.3	Hu
	26	9.9	Ba
	28	9.6	Ba
	28	9.3	B
	31	9.1	Ba
2	1	9.5	O
	1	9.3	Hu
	1	9.7	P

043274 X Camelop.

Mo.	Day	Est.	Obs.
12	27	10.2	L
1	5	10.9	Ba
	25	12.5	L
	26	12.5	Ba
	28	12.6	Ba

044617 V Tauri

Mo.	Day	Est.	Obs.
1	31	9.0	Ba
2	2	9.0	Y

045307 R Orionis

Mo.	Day	Est.	Obs.
1	26	11.6	Ba
2	2	11.0	Y

045514 R Leporis

Mo.	Day	Est.	Obs.
12	27	9.3	L
1	3	8.3	G
	5	7.5	Ba
	8	7.9	Ya
	8	8.2	G
	9	7.9	Ya
	10	7.8	B
	10	7.8	Ya
	18	8.2	G

VARIABLE STAR OBSERVATIONS Jan.-Feb., 1914.—Continued.

R Leporis

Mo.	Day	Est.	Obs.
1	19	8.3	Ya
	25	9.1	L
	26	7.5	Ba
	27	8.1	G
	28	8.1	B
	28	8.4	Ya
	30	8.1	G
2	1	7.7	Le

050003
V Orionis

1	30	9.1	G

050953
R Aurigae

1	1	8.8	B
	5	8.4	Bu
	26	8.0	Ba
	31	8.2	Ba
2	1	8.0	P

052034
S Aurigæ

1	1	9.4	B
	2	10.4	L
	10	9.2	B
	14	9.3	B
	26	9.3	Ba

052036
W Aurigæ

11	1	11.0	B
	13	10.5	V
	14	10.1	B
	14	10.3	Bu
	26	9.8	Ba
	31	9.7	Ba

052404
S Orionis

1	22	12.9	Fu
	26	12.5	Ba

053005
T Orionis

1	18	9.6	G
	27	9.8	G
	27	9.7	M
	28	10.0	Ba
	30	10.0	G
	31	10.0	Ba
2	1	9.8	M

054615
RU Tauri

2	2	12.5	Y

054629
R Columbae

1	31	10.0	G

054920
U Orionis

Mo.	Day	Est.	Obs.
1	18	11.0	G
	27	11.3	M
	28	11.5	Ba
	31	11.9	Ba
2	1	11.9	Hu
	2	11.6	Y

060450
X Aurigae

1	26	10.5	Ba

060547
SS Aurigae

1	16	11.9	H

060675
W Camelop

1	22	12.4	Fu

061702
V Monoc.

1	13	9.7	V
	26	8.5	Ba
	31	8.1	Ba

063159
U Lyncis

1	27	13.8	Ba
	31	13.6	Ba

064030
X Geminorum

1	25	11.2	O

064922
NOVA GEMIN. II

12	25	10.6	L
1	3	11.0	G
	8	11.0	G
	15	10.8	V
	25	10.8	L
	27	11.0	M
	27	11.0	Ba
	28	11.0	Ya
	30	11.1	Ya

065208
X Monoc.

1	2	8.9	L
	5	8.9	Ba
	8	8.6	G
	24	8.2	L
	27	8.0	G
	27	8.0	Ba
	30	8.0	G
	31	7.9	Ba

065355
R Lyncis

1	27	8.4	Ba

070109
V Can. Min.

2	2	11.9	Y

070122
R Gemin.

1	22	11.3	Hu
	28	11.0	B
	28	10.8	O
2	1	10.6	Hu

070310
R Can. Min.

1	2	8.4	L
	5	8.7	Ba
	8	8.9	G
	15	9.3	V
	18	9.0	O
	25	9.7	L
	27	9.4	G

071703
V Gemin.

2	2	8.3	Y

072708
S Can. Min.

12	27	9.4	L
1	3	8.7	G
	5	8.6	Bu
	8	8.4	G
	14	8.4	B
	15	8.4	H
	18	8.1	G
	18	8.4	O
	22	8.3	O
	22	8.2	B
	25	8.2	L
	25	8.0	L
	27	7.9	G
	27	7.6	M
	28	8.1	O
	30	7.9	G
2	1	8.0	O
	1	7.9	M
	5	7.9	S

072811
T Can. Min.

2	12	10.0	Y

073508
U Can. Min.

1	5	9.2	Ba
	5	9.4	Bu
	14	9.4	B
	14	9.8	Ba
	18	10.4	O
	22	10.5	Ba
	22	10.6	O
	23	9.9	L
	26	10.6	Ba

U Can. Min.

1	27	10.0	G
	30	10.5	G
	31	10.6	Ba
2	1	10.0	Hu
	2	10.6	Y

073723
S Gemin.

2	2	10.0	Y

074323
T Gemin.

2	2	10.1	Y

074922
U Gemin.

1	28	11.6	B

080322
RU Puppis

1	31	8.5	G

081112
R Cancri

12	25	11.3	L
1	22	10.5	O
	23	11.0	L
	27	10.9	Ba
	30	10.6	G
	31	10.6	Ba
2	1	11.0	M
	1	11.9	Hu

081617
V Cancri

1	22	9.2	O
	30	9.2	G

082405
RT Hydrae

1	5	7.9	Ba
	24	8.2	L
	27	8.1	Ba

083019
U Cancri

1	31	10.1	Ba

084803
S Hydrae

1	22	10.8	O
	30	10.8	G
	31	11.4	Ba
2	1	8.9	Hu

085120
T Cancri

1	2	9.6	L
	15	8.8	H
	22	9.3	O
	25	9.4	L
	27	8.2	Ba
	30	7.9	G

090425
W Cancri

Mo.	Day	Est.	Obs.
1	27	12.4	Ba
	31	12.2	Ba

093014
X Hydrae

1	31	11.5	G

093934
R Leo. Min.

1	30	7.5	G
2	5	7.9	S

094211
R Leonis

12	25	8.4	L
1	5	6.6	Ba
	8	6.0	G
	22	6.1	O
	22	6.0	Ba
	23	6.1	L
	25	5.8	L
	26	6.5	M
	26	6.0	Ba
	27	6.2	Ya
	27	6.4	M
	27	5.8	G
	28	6.2	Ya
	28	6.4	S
	30	5.7	G
	31	6.4	C
	31	5.9	Ba
2	1	6.6	M
	1	6.5	Le

094622
Y Hydrae

1	27	6.8	Ba
1	1	6.5	Ba

103012
U Hydrae

1	9	4.5	G
	25	4.6	L
	31	4.7	G
	31	4.9	C

103769
R Urs. Maj.

1	15	11.4	H
	26	13.3	Ba
	28	11.8	M
	31	13.1	Ba
2	1	11.7	M

105517
R Crateris

1	8	9.5	G
	30	9.2	G

113439
RU Urs. Maj.

1	22	10.7	Fu

VARIABLE STAR OBSERVATIONS Jan.-Feb., 1914.—Continued.

120012
SU Virginis
Mo. Day Est. Obs.
1 27 10.8 Ba
2 1 11.0 Ba

122001
SS Virginis
1 27 6.2 Ba

122532
T Can. Ven.
2 5 8.9 Y

123160
T Urs. Maj.
1 15 13.1 H
26 12.7 Ba
31 12.6 Ba

123307
R Virginis
1 27 7.2 Ba
2 2 7.5 M

123459
RS Urs. Maj.
1 22 12.4 Fu

132063
RR Urs. Maj.
1 22 10.0 Fu

123961
S Urs. Maj.
1 2 10.2 L
5 10.1 Ba
14 9.6 Ba
15 10.0 H
22 8.9 Ba
24 8.9 L
26 8.7 Ba
26 8.7 M
27 8.7 M
28 8.8 S
31 8.3 Ba
2 1 8.6 M
2 8.5 Le
5 8.7 S

124204
RU Virginis
1 27 12.7 Ba

132422
R Hydrae
1 2 7.6 L
8 7.8 G
23 7.0 L

132706
S Virginis
12 25 7.1 L
1 23 7.8 L
2 2 8.5 M

133273
T Urs. Min.
Mo. Day Est. Obs.
1 22 10.6 Fu
27 10.8 Ba
31 11.4 G

133674
V Urs. Min.
1 31 7.5 G

134440
R Can. Ven.
1 23 9.0 L
27 8.8 Ba
28 8.5 M
2 1 8.5 Ba
2 8.7 M

141567
U Urs. Min.
1 5 9.2 Ba
14 8.7 Ba
26 8.9 Ba
28 8.8 Ba
28 8.8 S
2 1 8.6 Ba

141954
S Boötis
1 23 10.3 L
27 10.4 Ba
2 1 10.1 Bu
2 9.8 M

142539
V Boötis
1 8 11.0 G
21 10.1 L
23 10.7 L
27 10.7 Ba
2 2 10.6 M

142584
R Camelop.
12 27 9.8 L
1 5 9.3 Ba
10 9.3 B
15 9.0 L
18 9.1 O
22 8.9 O
25 8.9 O
25 8.8 L
27 8.8 Ba
28 8.8 O
31 9.1 G
2 1 8.8 O
2 9.2 Le

143227
R Boötis
1 2 7.3 L
9 7.0 G
23 6.9 L
27 7.1 Ba
2 2 7.8 M

144918
U Boötis
2 1 11.2 Ba

150605
Y Librae
12 25 10.5 L
1 25 11.6 L

151520
S Librae
12 25 9.3 L
1 25 10.2 L

151731
S Cor. Bor.
12 25 12.1 L
2 2 8.0 M

151822
RS Librae
12 25 8.0 L
1 25 9.4 L

153378
S Urs. Min.
12 25 10.7 L
1 25 11.6 L
27 11.5 Bu
31 10.9 G

154428
R Cor. Bor.
12 25 6.0 L
1 8 5.8 G
9 5.6 H
23 6.0 L
25 6.0 L
26 5.7 G
2 1 5.8 Bu
2 6.1 M

154539
V Cor. Bor.
1 8 7.4 G
2 1 7.6 Ba

154615
R Serpentis
1 1 9.7 Ba

155847
X Herculis
1 25 6.3 L

160210
U Serpentis
2 1 11.0 Ba

160625
RU Herculis
1 1 8.5 Ba 2 2 9.0 M

161138
W Cor. Bor.
1 1 10.2 Ba
2 2 10.7 M

162119
U Herculis
1 29 9.3 M
2 2 9.2 M

163137
W Herculis
2 2 8.8 M

163172
R Urs. Min.
1 27 10.2 Ba
2 2 10.5 M

163266
R Draconis
1 27 11.5 Ba
2 1 11.4 Ba

164055
S Draconis
1 9 8.7 G

164715
S Herculis
1 1 11.8 Ba

170627
RT Herculis
1 1 11.4 Ba

175458
T Draconis
1 11.0 Ba

181136
W Lyrae
1 29 8.7 M
2 2 8.5 M

184205
R Scuti
1 25 5.5 L

193449
R Cygni
12 25 11.7 L
1 1 11.5 Ba
6 11.2 Ba
14 10.2 Ba
15 11.1 V
15 10.9 L
25 10.2 L
26 10.0 Ba
2 2 9.0 M

193732
TT Cygni
Mo. Day Est. Obs.
12 26 8.5 L
1 4 7.4 G
23 8.2 L

194048
RT Cygni
1 1 11.0 Ba
6 10.8 Ba
14 9.9 Ba
25 10.1 L
26 9.7 Ba
2 2 9.2 M

194348
TU Cygni
12 27 10.6 L
1 1 10.0 Ba
6 9.6 Ba
14 9.2 Ba
25 9.1 L
26 9.3 Ba

194632
χ Cygni
12 26 6.4 L
1 1 7.0 Ba
8 7.3 Ya
9 7.3 Ya
10 7.5 Ya
11 7.9 P
19 8.1 Ya
23 8.2 L

200647
SV Cygni
12 25 9.4 L
1 1 8.9 Ba
14 9.0 Ba
25 9.5 L

200938
RS Cygni
12 25 8.2 L
1 1 7.4 Ba
14 7.3 Ba
23 7.8 L

201647
U Cygni
11 25 10.2 L
1 1 8.9 Ba
4 9.8 G
14 9.1 Ba
25 11.0 L

202539
RW Cygni
1 1 8.0 Ba
4 8.2 G
14 8.4 Ba
18 9.0 P

VARIABLE STAR OBSERVATIONS Jan.-Feb., 1914.—Continued.

Mo.	Day	Est.	Obs.
RW Cygni			
1	27	8.5	Ya
	28	8.8	Ya
	30	9.1	Ya
202946			
SZ Cygni			
1	1	9.4	Ba
	5	10.0	Ba
	6	9.8	Ba
	10	8.7	B
	12	9.0	Le
	14	9.1	Ba
	14	9.4	Le
	23	9.5	Ba
	25	9.1	P
	26	9.0	Ba
	27	8.9	Ba
	27	9.3	Ya
	28	9.4	Ya
	30	9.3	Ya
202954			
ST Cygni			
1	1	10.3	Ba
	14	10.9	Ba
	26	11.2	Ba
204846			
RZ Cygni			
1	28	11.6	Y
205923			
R Vulpeculae			
12	27	9.1	L

Mo.	Day	Est.	Obs.
210868			
T Cephei			
12	27	6.7	L
1	1	7.0	Ba
	11	7.9	P
	14	8.0	P
	14	7.5	Ba
	15	7.3	V
	15	8.2	L
	18	8.2	P
	22	8.5	O
	22	8.1	Ba
	25	8.3	P
	25	8.4	L
	27	8.1	Ba
	28	8.6	O
	30	8.2	Ya
2	1	8.7	O
	1	8.3	P
213044			
W Cygni			
12	25	5.5	L
1	2	5.9	L
	4	6.0	G
	15	6.7	L
	24	6.7	L
	25	6.3	L
	26	6.3	L
213678			
S Cephei			
1	14	10.0	Ba
	22	10.8	Ba
	27	11.3	Ba

Mo.	Day	Est.	Obs.
213753			
RU Cygni			
1	8	8.0	G
	15	8.6	V
213843			
SS Cygni			
12	26	11.8	L
	27	12.0	L
1	6	11.9	Ba
	14	11.6	Ba
	14	11.7	C
	15	10.5	V
	15	10.5	L
	18	8.1	P
	22	8.3	Ba
	22	8.4	O
	22	8.6	B
	23	8.4	Ba
	24	8.4	L
	25	8.5	P
	25	8.2	J
	25	8.3	L
	25	8.8	O
	26	8.6	L
	26	8.8	Ba
	27	8.9	J
	27	9.1	Ba
	28	9.4	Y
	28	9.6	B
	28	9.3	Ba
	30	10.2	Ya
2	1	11.6	J
	2	11.5	Y

Mo.	Day	Est.	Obs.
213937			
RV Cygni			
12	25	6.8	L
1	1	6.9	Ba
	8	6.9	G
	11	7.1	P
	14	6.6	Ba
	14	7.4	P
	18	7.1	P
	25	7.0	P
	26	6.4	L
215934			
RT Pe6asi			
2	2	9.7	Y
222439			
S Lacertae			
1	28	12.0	Y
223841			
R Lacertae			
1	28	12.4	Y
230110			
R Pegasi			
12	27	9.3	L
1	11	9.8	P
	14	9.8	P
	18	9.7	P
	25	9.6	P
	25	9.6	L
	28	9.9	Ya
	30	9.8	Ya
230759			
V Cassiop.			
1	1	8.4	Ba
	4	7.8	G
	8	8.6	G
	14	9.5	P
	14	9.8	Ba

Mo.	Day	Est.	Obs.
V Cassiop.			
1	18	9.5	P
	18	9.5	O
	22	9.7	Ba
	22	9.7	O
	25	10.0	P
	25	9.8	O
	27	12.1	Ba
	28	10.0	O
2	1	10.4	O
	1	10.4	P
233335			
ST Androm.			
1	1	9.4	Ba
	6	9.9	Ba
	14	10.2	Ba
	18	9.1	O
	22	10.5	Ba
	25	10.8	P
	27	10.6	Ya
	28	10.6	Ba
	28	10.8	Ya
	30	10.3	Ya
2	1	10.9	P
235525			
Z Pegasi			
1	28	9.6	Y
	28	10.2	Ba
	28	10.5	V
235939			
SV Androm.			
1	1	11.4	Ba
	14	11.8	Ba
	22	12.2	Ba
	28	12.7	Ba
2	2	12.0	Y

No. of observations, 686; No. of stars observed, 149; No. of observers, 20.

During the past month positive observations were secured of twenty-four of the neglected variables as compared with fourteen last month.

Mr. Lemont Barbour has recently purchased a 4½″ refractor which will enable him to render an effective service. Credit is due to Mr. E. W. Putnam for the distribution of many blue prints. Mr. Yamasaki, a new member, contributes his first list this month. He secured 43 estimates and is to be congratulated on the good start he has made. It is a pleasure to welcome Miss Young's return to the active list. Her observations of the neglected variables are greatly appreciated.

The English Mechanic cites the following dates of maxima of variables:

Jan.	8	093934 R Leonis Minoris
	11	050953 R Aurigae
	22	090425 W Cancri
	24	143227 R Bootis

In the case of 090435 W Cancri, Mr. Bancroft's observations would indicate that the elements needed revision.

The variable 213843 SS Cygni attained a maximum about the 18th of January. It was observed at this interesting period by a number of our observers. The observations of 043208 RX Tauri are worthy of note. Dr. Hartwig states its range as 10.0

to < 11.0. Our observations indicate a higher maximum for this variable this month. Such features of the work as this add greatly to the fascination and attest the practical nature of our work.

The variable 230759 V Cassiopeiae has waned of late with remarkable rapidity, a full magnitude in 18 days. *021403 o* Ceti, on the contrary, has waxed with equal suddenness and has now attained naked-eye brilliance.

Attention is called to the exceedingly interesting address of Professor Pickering to the American Association for the Advancement of Science at Atlanta, Ga., December 29, which is published in POPULAR ASTRONOMY for February. Reference is made to variable star observing and Professor Pickering thus vouches for its practical nature: "The most useful work that an amateur can do with a small telescope is the observation of these objects." Surely such a statement should induce many telescopists to take up this work.

The following members contributed observations to this report: Messrs. Bancroft, Bouton, Burbeck, Craig, Eaton, Gray, Guthrie, Hunter, Huntington, Jacobs, Lacchini, Leonard, McAteer, Olcott, Putnam, Vrooman, Yamasaki and Miss Furness, Miss Swartz and Miss Young.

WILLIAM TYLER OLCOTT.
Corresponding Secretary.

Norwich, Conn., Feb. 10, 1914.

COMMUNICATIONS.

The Advent of Arcturus.—To those who dwell under northern skies, the advent as Arcturus signifies the coming of spring. Of course, Leo and the approach of Ursa Major also signify in a way the advent of Spring; but Leo is somewhat of a winter constellation and Ursa Major is always with us. Queen Vega can hardly be called, owing to its later rising, a firmamental harbinger of spring, and Spica, also rises later than great and glittering Arcturus. Arcturus therefore is spring's truest harbinger, becoming conspicuous before the 21st day of March.

First, Nekker, then Izar, and at last Arcturus! First, the top of the constellation Boötis and then the bottom. King Sol has set, the gloaming comes and goes, the star-kings in the respectlve order of their brilliance awaken to the eyes of men. Like a fitting background to the sparkling suns of night, the ebon blackness of the firmament overhangs terrestrial hills and vales. Evening is once more regnant, and the voice of the village clock intones the hour of *nine*. Under the darkened dome man stands in silence, gazing enraptured upon the sidereal display above him. How wonderful, how beautiful it all is! Westwardly, winter's most glorious galaxy seems slowly drifting, soon to disappear from evenings northern firmament. Northwardly, Polaris sparkles like a minute diamond-pivot of the darkened skies. Southwardly, King Sirius still reigns in glorious splendor. And, then, man looks toward the east. For a moment the sky seems unusually dark and uninteresting in this part of the bespangled firmament; but suddenly from behind some little knoll a bright star-diamond sparkles upon the sight, and a scintillating monarch of the night arouses wonder and admiration.

Arcturus of Boötes! Magnificent in the early freshness of his fire. Glittering and glowing like a titanic sky-jewel. Far remote is he, yet seeming close at hand; conspicuously brilliant but far, far away. A sidereal furnace, a fiery ship amid the ether, speeding furiously forward as though upon some sealed and mysterious commission, dragging perchance along with him a system of satellites and planets,

threatening utter destruction, on collision, to lesser suns and utter death to possible inhabited worlds. A gigantic, silent sun whose progress and energy are almost inexpressibly terrific. A sidereal ship bombarding the universe with incalculable light rays; a fiery ship that must in all probability become, as the ages of Eternity pass by, a derelict, as cold and invisible as a reef in a pitchy-black night. An unseen menace to the other members of our universe, that suddenly sweeping vast and violently upon some dead or dying solar system—it may be indeed our own—disrupts it asunder, causing for a while some of its shattered fragments to kindle anew with the terrible fury of the impact.

Once more the advent of Arcturus; once more the coming of spring! The winter with its snow, ice and cold, has gone; spring, with its birds and flowers, has come; and the suns and constellations of spring reign again amid the darkened dome. Vega and Spica are beginning to adorn their respective skies; but Arcturus is indeed greater than either Vega or Spica. In summer he is monarch of evening's bespangled firmament, glowing and glittering on high. In spring he sparkles and scintillates splendidly in the east as Sirius is sparkling and scintilating gloriously towards the west. With the closing weeks of winter, he rises to the terrestrial view of man—in firmamental fire and glory—the harbinger of spring and awakenment of nature.

CHARLES NEVERS HOLMES.

Dover, N. H., 147 Locust Street.

Variation in the Period of Halley's Comet.—I am enclosing a graphical representation of the various intervals or periods of Halley's comet from B. C. 240 to 1910, according to data found in Chamber's "Story of the Comets," pp. 116-117.

In Fig. 1, I would call attention to the apparent regular returns of the shortest and longest periods; the time from shortest, A. D. 141.2 and 912.2, to longest period, 530.8 and 1301.8, being in each case 389.6 years. While the decline from longest to shortest was accomplished in one case in 381.4 years and in the other in 380.9 years, or the interval covering ten periods of revolution in each case was from shortest period to shortest period again 771 years and 770.5 respectively. A curious feature

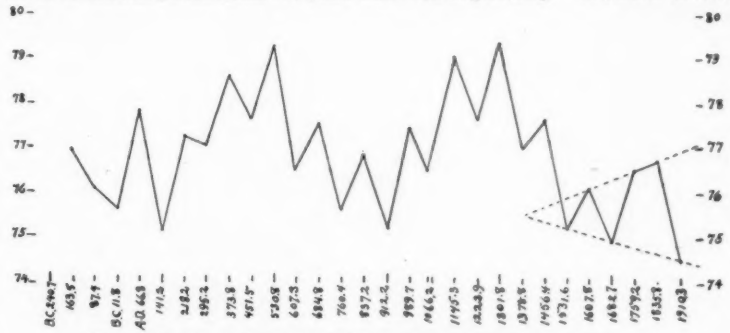


FIG. 1. DIAGRAM SHOWING THE VARIATION IN LENGTH OF SUCCESSIVE PERIODS OF HALLEY'S COMET.

The numbers at the margin represent the length of the period in years, those at the base of the cut the years of successive apparition.

noticeable in the late periods is shown by the dotted lines in Fig. 1. Fig. 2 is a replotting of Fig. 1 according to a "cycle" of 10 periods of revolution beginning with the shortest. The reader will notice the remarkable similarity in general form and

close coincidence of the lines representing the periods during the "cycles" 141.2 to 912.2 and 912.2 to 1682.7. The lines representing the periods before 141.2 agree fairly well in form and coincidence, except that for the seventh period of the cycle, B. C. 87.4. The lines representing the interval of time since 1682.7 agree at first fairly well, but the period ending in the 1910 apparition, instead of being a fairly long one, went the other way and was the shortest of all, being the most marked exception to the "cycle".

It would appear that the "cycle" is shortening about half a year at each of the successive returns as shown in Fig. 2 for years 141.2, 912.2 and 1682.7 and the length of "cycles" given. It will be readily seen that the periods of revolution are alternately short and long (with only three exceptions out of 28: —B.C. 87.4; 1835.8; 1910.3), and on looking for the cause I find it is undoubtedly due to Jupiter, for two revolutions of the comet equal thirteen of Jupiter (using for the comet's period 77.09 years, though the mean of the two cycle periods 141.2 to 1682.7 gives 77.075) and therefore Jupiter would alternately be in the opposite part of his orbit, that is if near comet's path at one apparition he would not be at the next apparition.

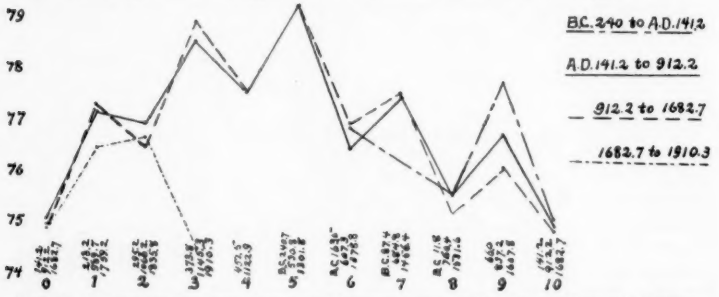


FIG. 2. DIAGRAMS SHOWING CYCLE OF VARIATION IN THE PERIOD OF HALLEY'S COMET.

It should also be remarked that eight revolutions of the comet equal approximately 21 of Saturn, 12 periods of the comet nearly 11 periods of Uranus and 17 periods of the comet nearly eight periods of Neptune (more exactly 80 comet periods equal 171 periods of Neptune.)

It thus appears that the periods of these four planets are approximately commensurable with 2, 8, 12 and 17 returns of the comet respectively, and in the light of this, why the "cycle" apparently comes out in ten period intervals is not patent to me, unless Saturn's 8 and Uranus' 12 split the difference, so to speak, which does not seem probable.

Note the gradual stepping down or shortening of the period at 9.

It would be interesting to know whether the apparitions observed previous to B. C. 240 agree with this "cycle" (?) or whether these two apparent cycles are the result of mere coincidence. It would also be of interest to know whether the next return will be according to the "cycle" (when it should be in perihelion about 1987.9) or according to the dotted line arrangement in Fig. 1, or neither; and whether the apparent breaking down of the general form of the "cycle" in 1910 will recover itself so that the longest period comes at the same place and time it did in the two previous "cycles".

Now if the perturbations cause the periods of revolution of Halley's Comet to run through "cycles" as the graph Fig. 2 seems to indicate, why not for other comets, at least for those whose periods are commensurable with those of the planets,

This subject is pretty deep for me, just a surveyor and an amateur in astronomy but possibly some Newton or Crommelin may be able to unravel it, if his attention is called to it.

DAVID A. BLENCOE.

Superior, Wis.

GENERAL NOTES.

Sir David Gill, for many years astronomer at the Cape of Good Hope, died on January 24, at the age of seventy years.

Dr. Julius Scheiner, astronomer in the Potsdam Astrophysical Observatory, died on December 20, 1913.

Dr. Charles E. St. John, of the Mt. Wilson Solar observatory, delivered a lecture on the subject of Astronomy and Astrophysics, on the evening of February 10, before the monthly meeting of the Los Angeles Astronomical Society held in the Los Angeles high school. An audience of some two hundred people listened attentively to Dr. St. John's lecture, which was illustrated with a number of stereopticon slides showing the Mt. Wilson instruments, buildings, and some valuable results obtained with the former.

Prizes in Astronomy.—The prizes in astronomy of the Paris Academy of Sciences have been awarded as follows: The Francœur prize to A. Claude, for the whole of his astronomical works; the Lalande prize to J. Bosler, for his researches on the sudden variations of terrestrial magnetism and their connection with disturbances in the sun: the Valz prize to Professor A. Fowler, for his researches in spectroscopy; the G. de Pontècoulant prize to M. Sundmann, for his researches on the problem of three bodies.

The New Telescope for the Chabot Observatory.—The new telescope of 20-inches aperture for the Chabot Observatory is now in actual progress of building.

After the necessary legal advertising for bids, the offer of the Warner & Swasey company was accepted and the telescope ordered. The optical parts are to be furnished by Brashear. The objective is to be of Yena glass with a focal length of 28 feet, two finders, of 4½ and 3 inches, micrometer, sidereal dial, quick motion in R. A., coarse and fine graduation of circles, driving clock wound by electric motor, full electric illumination of circles, etc.

The disks for the objective have already been ordered and the Warner & Swasey Company are at work on the mounting, which the Company will exhibit at the Panama Pacific Exposition. It is expected that the objective will be furnished before the exposition closes, when the telescope will be taken to Oakland and installed in the new Observatory, which will be built the coming autumn, on a site several miles from the business part of the city, where the present observatory is located.

Fellowships in the Lick Observatory.—The following circular issued by Professor W. W. Campbell, director of the Lick Observatory, shows what is being done in California to assist worthy students in astronomy. Their example might well be followed at other observatories where friends may be interested to furnish the means.

UNIVERSITY FELLOWSHIPS.

The Regents of the University of California maintain three fellowships in the Lick Astronomical Department. These usually permit the holders to pursue studies and to undertake investigations in fulfilment of requirements for the degree of Doctor of Philosophy, with residence on Mount Hamilton during eight months of the year and in Berkeley during one semester of the year. Occasionally, however, the holder of the fellowship has the preparation which permits him to reside on Mount Hamilton throughout the year. The successful filling of a fellowship favors reappointment for second and third years. It is essential that the applicant shall be a graduate of a college or university of high standing, and shall have decided to make astronomy or one of the related sciences the basis of a professional career.

The stipend of each fellowship is $600 per annum. The necessary living expenses on Mount Hamilton range from $28 to $32, and at Berkeley from $35 to $40 per month.

Applications should be made in writing to the Director of the Lick Observatory. Each should be accompanied by a brief biography of the applicant, including details of his academic career. Supporting letters from instructors of established reputation are given great weight. Appointments are for the academic year beginning with July 1, and applications should be presented early in the preceding six months, preferably before April 1.

MARTIN KELLOGG FELLOWSHIP.

A fellowship in the Lick Astronomica Department has been endowed by Mrs. Louise W. B. Kellogg, in memory of her husband Martin Kellogg, whose services to the University of California as professor and president covered nearly half a century.

The purpose of the Martin Kellogg Fellowship is to provide opportunities for advanced instruction and for research, to students who have already received the degree of Doctor of Philosophy, or an equivalent, or to members of the staffs of observatories. Preference will be given to qualified applicants who may desire to pursue studies or researches in the Lick Astronomical Department, or in the Lick and Berkeley Astronomical Departments, and to members of the Lick Astronomical Department who may desire to undertake definite work in another university or observatory; but it is possible that opportunities will arise to award this fellowship, in cases of special merit without restrictions as to address of applicants or proposed residence of holders.

The stipend is variable in amount, but is sufficient to cover all necessary expenses of travel and residence. Applications, including outlines of proposed plans and estimates of necessary expenses, should be made in writing to the Director of the Lick Observatory. They should include brief biographies, with special reference to the academic careers of the applicants. Supporting letters from instructors of recognized standing will carry great weight. Appointments usually cover the year beginning with August 15, but this provision is not a fixed one. Applications will be welcomed at any time from January to July, but preferably before April 1.

W. W. CAMPBELL,
Director.

The Washington Daily Time Signals.—It may be of interest to our readers to know the degree of accuracy with which the time signals are sent out from the United States Naval Observatory. Captain Hoogewerf, superintendent of the Observatory has very kindly communicated the following list of the errors, as made up at the end of the month, for January, 1914.

Errors of the noon and 10 P. M. Time Signals as sent out by the Naval Observatory during the month of January, 1914.

Day		Error Noon	10 P.M.	
		s	s	
Jan.	1	−.04	−.04	
	2	−.03	−.03	
	3	+.01	.....	Arlington out of commission.
	4	+.01	+.02	
	5	+.04	+.04	
	6	+.07	+.05	
	7	+.07	+0.6	Sunday
	8	+.00	−.02	
	9	−.06	−.05	
	10	−.04	−.06	
	11	−.05	−.05	
	12	−.06	−.08	
	13	−.09	+.02	
	14	+.05	+.06	Sunday
	15	+.07	+.11	
	16	+.10	+.10	
	17	+.03	−.11	
	18	.00	−.03	
	19	.00	−.01	
	20	.00	−.03	
	21	−.01	−.01	Sunday
	22	−.03	−.03	
	23	−.03	−.06	
	24	−.00	+.04	
	25	+.04	+.07	
	26	+.05	+.07	
	27	+.11	+.07	
	28	+.05	+.04	Sunday
	29	+.07	+.09	
	30	−.23	+.14	
	31	+.16	+.19	

(−) fast (+) slow

First Observations in Astronomy.—A handbook for schools and colleges by Mary E. Byrd, Ph. D., former director of Smith College Observatory, teacher of astronomy in the Normal College of the city of New York. Price $1.

This handbook contains very little descriptive astronomy, but is devoted wholly to the statement of laboratory methods by which the student is made to gain his own facts by observation with simple inexpensive apparatus, much of it to be constructed by himself. There is no question as to the value of this method for developing independence in work and thought, and Miss Byrd, being a practical teacher, has been able to put together a set of problems and instructions that others will doubtless be able to use. The book contains 126 pages and the problems outlined may very well go along with a semester or even a year course in descriptive astronomy. The book is to be obtained only from Miss Byrd herself.

Astronomy, by Ellison Hawks. Milner and Company, 11 Dyche Street Manchester, England, 1913.

This is a small book of 120 pages written for the popular reader; a part of the "XXth Century Science Series." The most interesting facts of astronomy are compressed into small space, without mathematical discussion. One could wish there were more and better illustrations, but in other respects the book is well up to date and should find place in public and private libraries.

Astronomy, by George F. Chambers, F. R. A. S. D. Van Nostrand Company New York, 1913. 335 pp. Price $1.50.

Mr. Chambers has written a number of books on astronomy, the best known being "A Handbook of Astronomy", which has run through at least four editions, and "The Story of the Comets". The new book is written in the same interesting style and is illustrated with many cuts of excellent quality. As the author says in his preface "there is nothing profound or inconveniently deep in it, but it just gives a popular outline of leading facts, which may be easily grasped by any fairly educated person who is only able, or disposed, to give a limited amount of time or thought to the matter, but who may happen to possess a small telescope of, say, two or three inches aperture, or even a good opera-glass."

Publications Received.

Annals of the Astronomical Observatory of Harvard College, Vol. LXXII, No. 6. Scale of the Bonn Durchmusterung. No. 7. Scale of the Cordoba Durchmusterung.

Porter, J. G., Exercises celebrating the opening of the Mitchell Observatory, October 29, 1912.

Dyson, F. W. and E. W. Maunder, The position of the Sun's axis determined from photographs of the Sun from 1874 to 1912, measured at the Royal Observatory, Greenwich.

Mean areas and heliographic latitudes of sun-spots in the year 1912. *Monthly Notices* R. A. S., Supplement, 1913.

Annuario Astronomico pel 1913 publicato dal R. Osservatorio di Torino.

Rainaldi, B., Osservazioni meteorologiche fette nell' anno 1911 all' Osservatorio della R. Universitä di Torino.

Boccardi, G., Il nuovo Osservatorio di Torino.

Puente, C., Determinacion de la Latitud por la Observacion de Distance Cenitales de la estralla polar. Madrid, 1910.

Cambridge Observatory, Annual report of the Observatory Syndicate, 1912 May 19-1913 May 18.

Rigge, Wm. F., A heliostat for the lecture room.

Padova, E., Osservazioni fotometriche di pianeti.

Padova, E., Osservazioni astrafotometriche.

Bailey, Solon I., Variable Stars in the Cluster Messier 3. Annals of Harvard College Observatory, Vol. 78, part 1.

Strömgren, E., Publikationer og mindre Meddelelser fra Köbenhavns Observatorium, No. 15.

King, Edward S., Absorbing Medium in space. Annals of Harvard College Observatory, Vol. 76, No. 1.

Hinton, I. T., The cause of planetary rotation, also a theory as to the tail of the comet.

The Journal of the Astronomical Society of Wales for 1912.

Carothers, W. F., The Central law of the weather. Carothers Observatory Bulletin No. 1.